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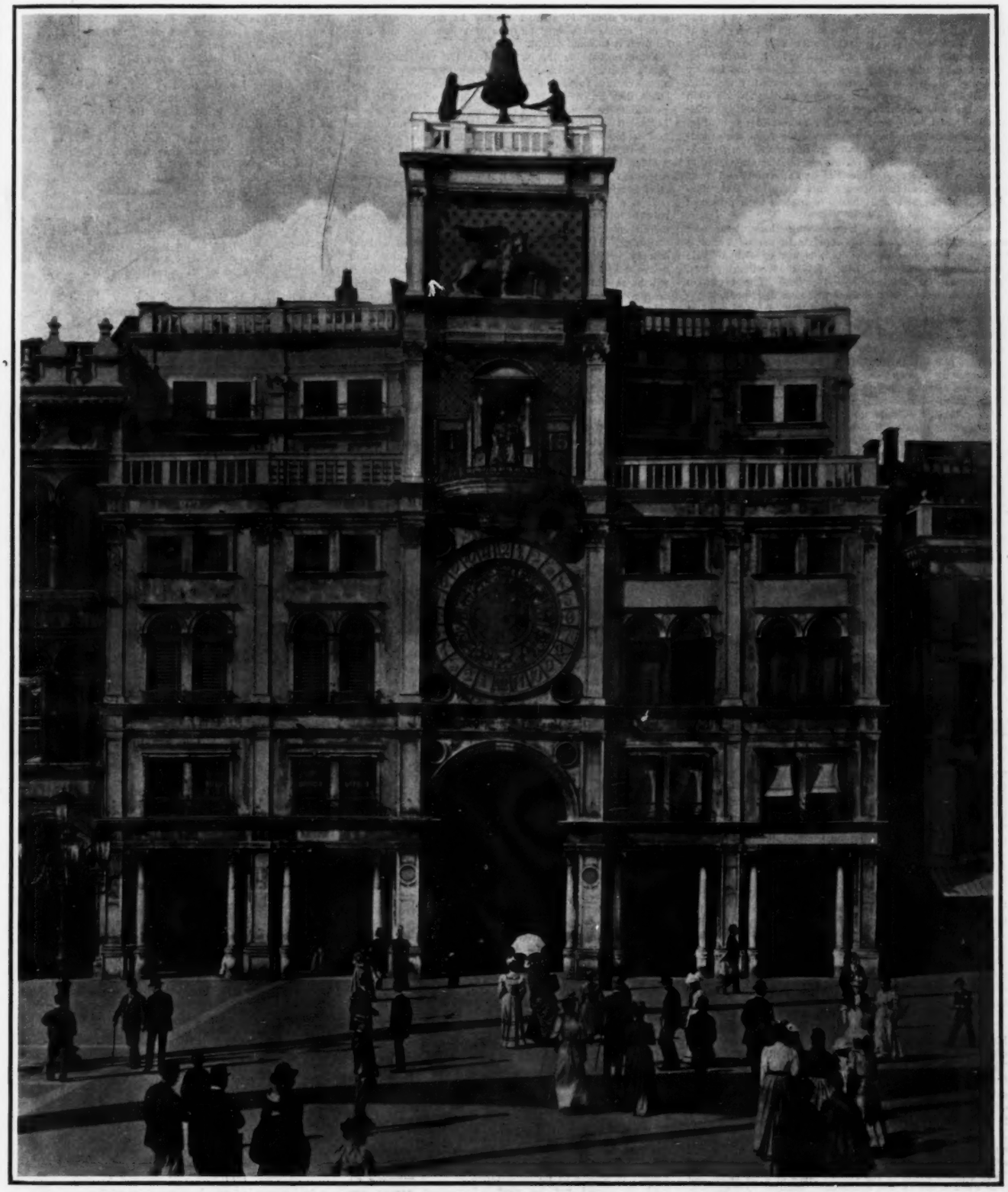


THE CLOCK TOWER AT VENICE, SHOWING THE BRONZE MOORS AND BELL; THE WINGED LION OF ST. MARK'S; THE VIRGIN AND INFANT; AND THE GREAT DIAL

THE FAMOUS ASTRONOMICAL CLOCK OF VENICE—[See page 136]

Selection and Treatment of Alloy Steels for Automobiles*

Why You Can Buy a Good Car for Little Money

By Henry Souther

A popular remark during the last few years has been to the effect that the steel business has advanced and changed rapidly and that the incentive is found in the manufacture of automobiles. This condition still continues and the evolution within the construction of the car itself is no less rapid. Design, materials, style and selling methods are all involved.

Curiously enough, it would seem at first glance that the choice of materials is involved in all of these four branches of the industry and not in the one or two as would seem natural.

The reasonable use of materials is to be the theme of this paper. Many considerations are involved in looking back to the beginning of the automobile industry and it seems necessary to do this in order that the evolution may be followed as far as materials are concerned.

At the beginning every faculty of designer and builder was focused on the production of an operative machine. Materials were disregarded so long as they would help build the vehicle and were obviously steel, brass, aluminum or wood. All were too busy to regard the quality. Generally speaking there were available from the standpoint of the automobile builder Bessemer steel, open-hearth steel and cast or crucible steel. Variations within these classes were regarded as unimportant and heat treatment was an unknown term: Certainly only theoretical at the best and therefore useless to a practical man.

Now these same men have among them those who state that the heat treating department of the works is the most important of all. This is not so with all yet; there are some who still balk at talk of critical points, recalescence, pyrometers and the like. The evolution is rapid however and this class will soon disappear.

After a year or two the cars operated very well; at least well enough to run long enough to break parts, crank shafts, axles and steering parts. Then a little attention was directed toward steel. There seemed to be no clear idea of a cure. If a steel part broke with an appearance of brittleness good old wrought iron was tried as a sure cure. If bending occurred tool steel was tried in some cases and medium carbons (0.50 per cent.) in others; it being understood that high carbons were stronger but brittle. The natural or annealed state was the only one known to the automobile industry at this time.

At about this time nickel steel was mentioned as a possibility. It had been used, or as some said "advertised as used" for bicycle construction. But generally it was regarded as something fancy and not worthy of the consideration of hard headed men. It was expensive, hard to work and no good anyway in the opinion of many.

So when alloys came along in earnest and were offered systematically by steel agents they had a hard time making any progress. The high prices quoted were laughed at. There seemed to be no chance that alloys would ever be given a fair trial. After some little time and persistence by the steel agent, alloy steels were tried and proven good even at 15 cents per pound. Some designs required alloy steels to stop breakage the result of small dimensions, sharp corners where fillets should be, and similar mistakes. In this way the alloy, or perhaps the high quality carbon steel, had a chance to make good in a spectacular way. These instances helped the spread of high grade steels until now the pendulum has swung too far and alloys are used where they need not be and money is thereby wasted. There is indication of a notion that an alloy steel is a cure-all; and that if needed in one part that it must be a fine thing in all parts.

Unfortunately the art of heat treatment has not spread as fast as alloy steels have and many cases exist where very expensive steels have been put into cars in an annealed or forged condition; which is absolutely unreasonable. The alloy steel is no cure-all and must be used intelligently, if any compensation for increased cost is to be realized.

A case in point is found in an engine crank shaft. It is large for the duty. If it is made of an alloy treated up to 100,000 lbs. per sq. inch or more, when 60,000 lbs. would suffice there has been no gain to the automobile and there has been a money waste. It is not generally understood that a high elastic limit adds nothing to the stiffness or rigidity of a part. It does add to resistance to fatigue but with the case in point the shaft is over size and fatigue cannot take place in the absence of bending.

The same general condition applies to gears of all kinds. It is not the rule, by any means, that gears of smallest section are made of the strongest steels. This should be so and is so in one very marked case. On the other hand many very heavy gear sets, duty considered, contain steel of greatest strength and all out of proportion to necessity. This is unreasonable as it is obvious that strength should be a function of design. A bridge or a building is calculated to a nicety, as yet automobiles rarely are. Knowledge of steel is not yet sufficiently wide-spread. The history of the automobile is short and there has not been time enough to disseminate knowledge of so many special steels and special treatments. Then, too, an air of mystery regarding special steels and secret treatments has been fostered in some circles in such a way as to befog the issue and retard the spread of truth.

At the beginning of the automobile art the steel industry was old. Alloys and heat treatments were no mysteries to the steel metallurgist. Makers of armor plate, gun tubes, propeller shafts and other important specialties had been using many grades of steel and many treatments to meet peculiar needs. This knowledge had not and does not spread readily to makers of small arms, sewing-machines, bicycles or typewriters and they all need it to some extent.

Some reason for this is found in the "old fashioned" selling methods of many steel companies. Most salesmen are not furnished with accurate knowledge of the steels they sell or if they are, they are forbidden to use such knowledge on possible customers. They use a line of argument that contains no metallurgical information and is too often far from the truth. There are large numbers constantly engaged in this way so it is no wonder that little real progress is made by aid of the salesman. Fancy names and fancy prices for common steel is their specialty.

It is a pleasure to feel that such methods are giving way to others and better. The steel works engineer, metallurgist or chemist is now placed in contact with the consumer. His wants are learned and supplied without secrecy or mystery. The opportunities of change and improvement are pointed out and advance in the art will be rapid. As it is now there is but little knowledge, among consumers, as to the relative importance of analysis and heat treatment or of the importance of casting, rolling, hammering and cold working of steels. Consequently many consumers are in doubt as to what to believe, the truth as expounded by the conservative metallurgist or the near truths about the special alloys of the salesman.

Before taking up the finer steels it is well to study the history of what preceded them in the automobile art.

At the outset carbon steels were mostly considered and known as machine steel. Such steel was available and cheap, or at least low in first cost. Such steel is not always cheap, as much of it tends in machining to such an extent that work is ruined or will not permit the cutting of a thread at all because of its softness. Such machine steel is of about the following composition. It is not strictly speaking machine steel but there is so much of it on the market, so called, that it must be recognized. Carbon 0.08 to 0.13 per cent., phosphorus 0.08 to 0.10 per cent., manganese 0.40 to 0.60 per cent., and sulphur 0.06 to 0.08 per cent.

Machine steel, so called, as found in steel warehouses is not all alike by any means. This lack of uniformity is discovered by the user whose judgment usually is that the steel is no good anyway and does not behave twice alike in the machine shop.

The best machine steel, then existing, in stock, was of about the following composition with carbon from 0.18 to 0.25 per cent., with other elements like the foregoing analysis. Such steel machines smoothly and cuts a keen thread. A slight increase in carbon coupled with the other elements given makes a very marked difference in machining quality. A third quality of machine steel found on the market at the time in question was between the other two in carbon contents and much higher in manganese, analyzing about as follows: carbon 0.12 to 0.18 per cent., phosphorus and sulphur about 0.08 per cent., and manganese from 0.60 to 0.90 per cent. The manganese contents made for smooth cutting and the steel was a good one for carriage axles, which must be machined very rapidly, and other similar uses.

These machine steels were all characteristic of Bessemer output and were put into the early automobiles. They answered the purpose until the machines began to wear fairly well and poor (weak) design developed. High carbons were tried and wrought-iron was tried all in a blind, unreasoning way. Some troubles were cured but some could not be cured by any change of material known at the time. The details of design were such as to cause failure with any material. Failure was delayed but not prevented.

One grade of steel, common then and now, known as screw stock, deserves notice; as it plays a more important part in automobile construction that it ought to. It is close to machine steel and is sometimes sold as such. The approximate analysis is as follows: carbon 0.08 to 0.12 per cent., phosphorus 0.12 to 0.18 per cent., manganese about 0.50 per cent., sulphur about 0.10 per cent. The dominant element, that makes for easy cutting, is phosphorus, which is twice normal for Bessemer steel. More steel of this quality than of any other composition, can be put through an automatic screw machine in a given time, and turn out a fine product. But the drawback is phosphorus, which causes brittleness in steel and makes it unsafe for automobile construction. Except in screws of no importance or parts carrying no load, it should not be used. Important screws are now made of alloy steels heat-treated. Connecting-rod and engine-base screws for example. The above screw stock after casehardening, as it often is, shows a coarse brittle grain even with the best of treatment. No hardened parts of this quality should be used.

At the present time little steel high in phosphorus finds its way into automobile construction. Basic Open Hearth steel is mostly used and this is uniformly below 0.04 per cent. in both phosphorus and sulphur.

This quality of steel in the vicinity of 0.10 per cent. carbon machines with the greatest difficulty, consequently a standard machine steel has been developed containing enough carbon and manganese to offset the softness. The analysis is as follows: carbon 0.20 to 0.30 per cent., phosphorus and sulphur not over 0.04 per cent., manganese 0.40 to 0.70 per cent.

This quality of machine steel handles well in every stage of manufacture and responds to heat treatment in a way that makes the product suitable for many parts of a car. This steel is a fine steel for general run of drop forgings. It is suited for the important members of low priced light cars, and for carbonized and hardened bevel and transmission gears in such cars as are of low power and generous gear design.

With the general use of basic open-hearth steel this type of machine steel is bound to be generally adopted. Its usefulness is very wide-spread and its cost as low as any open-hearth steel. The extra expense that is warranted is the care necessary to free from seams or other physical defects. This is done by the steel maker or the one who prepares the billets or bars for shipment. Freedom from seams insures a sound product at the finish of an expensive series of operations and is worth paying for.

Simple heat treatment will give an elastic limit per sq. inch of 60,000 lbs. This is the result of quenching at about 1,500 deg. F. in oil, then partially annealing at 800 deg. or 900 deg. F. Such strength is accompanied by good refinement of grain and corresponding toughness and capacity to resist shock and repeated alternate stress. The machine steels previously mentioned would not be safe under the foregoing treatment or any other; as refinement of grain does not take place to a satisfactory extent in the presence of so large a percentage of impurities.

Without a fine grain development in steel, fatigue takes place very rapidly. In using this term "fatigue" the same phenomenon is in mind that is often referred to as crystallization. Cold crystallization does not take place. It is a different physical change and will be discussed later.

About the years 1893-1894 bicycle parts often failed (to quote) "while riding along the smoothest road." The fractures did not exhibit coarse crystals as a rule, particularly in cold-drawn spoke wire or tubing. But in every case there did exist an opportunity for concentration of strains, bending or vibration, at a limited section. These failures led to studies of fatigue conditions.

It was commonly thought by well trained mechanics that the softest, toughest steels would resist longest under these conditions simply because of the tough quality. This was found to be not so. Tough and soft steel is weak steel having an elastic limit per sq. inch from 30,000 to 40,000 lbs. A good grade of 0.40 per cent carbon steel may have an elastic limit of 50,000 or 60,000 lbs. Such steels in an annealed condition were compared under such circumstances as to produce a fatigue break. The dead or actual load used in comparison was the same. This load was chosen to produce a fiber stress nearly as great as the elastic limit of the weaker steel, say 25,000 lbs. per sq. inch (about 84 per cent.). This stress was only 50 per cent. of the elastic limit of the stronger steel. The weaker steel, soft and tough, broke quickly after 20,000 to 50,000 alternations of stress. The stronger steel looked upon as being brittle and hard, endured say 400,000 alternations of stress, an increase not in direct proportion to strength and quite contrary to the characteristic of toughness as measured by elongation. It is evident that the toughness was not the controlling element under fatigue conditions and that strength as indicated by elastic limit was an important factor with some other element not obvious, playing an important role. Such an element was sought in the crystalline structure. Such structure is fairly indicated by transverse fracture for the purpose in hand. The fracture of the low-carbon tough steel is coarse grained with crystals presenting large cleavage planes. That of the higher carbon, brittle steel, showed a close grained structure with no crystals having cleavage planes of conspicuous size. That is, the steel that endured longer was strong and fine grained. These were the controlling elements.

It is for this object that all heat treating processes are practised—top produce greater strength and to refine the grain. The most reasonable steel to use in automobiles is that which will respond best to treatment or that will respond sufficiently for a given purpose, dimensions and duty considered. There is no reason in selecting a steel that will not respond somewhere in proportion to the cost of the operation; that is, the improvement must be material. Neither is it reasonable to select a steel at great cost that will respond to such an extent as to be way beyond the necessities of the case.

The treatment necessary to give a steel depends some-

*This paper treats of the various kinds of alloy steels and their applications in the automobile industry. Attention is called to the necessity of selecting steels which will do most efficiently the particular work for which they are intended.

what upon the physical condition of the steel as received by the consumer or user. For example, it is quite possible and often happens that bars of steel reach the manufacturer of automobile parts in a very coarsely crystallized state, this being due to the last forging or hammering operation prior to shipment by the steel mill. If this steel is to be used by the parts maker without further drop forging or other heating operations, the steel must receive a thorough annealing. In the absence of such annealing operation, which will reduce the coarse condition of it to a properly refined condition, a single heat treatment will not produce the expected results.

If, on the other hand, the bar or billet is to be forged, then this coarse crystalline condition matters but little and the annealing must necessarily follow the forging operation and for the same reason; to guard against a possible condition of coarse crystallization which will not be refined by a single heat treatment.

Our steel makers would do well to learn whether or not the consumer of the steel is to again forge. If not, annealing should be the final operation at the steel works in all cases. Otherwise, steel of good quality may not perform as well as it should.

It is not always possible for the steel manufacturer to know whether or not steel is to be forged again and, in view of that fact, it is the habitual practice of some of the steel mills to anneal as a final operation. No harm is done if the steel is again forged, and if not forged the steel is found, by the user, to be uniform in machining qualities and well behaved under heat treatment. Uniformity of machining quality is of far more importance in the eyes of the mechanic than is fully appreciated by many steel companies. Many thoroughly good qualities and shipments of steels are complained of and perhaps condemned because of the presence of so-called hard spots and bad cutting qualities. The machine shop cannot be expected to know that it is not the composition of the steel that is at fault and the steel maker should guard against such complaints by the relatively inexpensive operation of annealing.

These remarks apply very strongly to tool steels that are to be shaped into expensive tools, to spring steels and to the higher carbon steels in general. They apply in a lesser degree to the lower carbon steels but nevertheless are of great importance.

Many machine steels are condemned because tools are rapidly dulled in machining them and the complaint is, as a rule, that they are too hard to cut. As a matter of fact they are too soft to cut smoothly. They tear and cling to the point or edge of a tool and the cutting operation becomes more or less of a rubbing operation which creates heat and dulls the tool by softening it. Proper annealing, suited to the carbon, will correct this fault, but the machine shop manager cannot be expected to know this and probably has no facilities for annealing or other heat treatments in many cases.

Take an engine crank for example. Other considerations than strength influence the design. It must have ample diameter to furnish adequate bearing surfaces. It must be rigid and stiff. No alloy can increase this latter quality. A steel with 60,000 lbs. elastic limit per sq. inch is quite strong enough to outlast the engine. One of 200,000 lbs. elastic limit would make no better crank shaft under the assumed conditions and would cost more at first cost, in forge, in machine-shop, and in heat treatment. This is a fair example of unreasonable use of alloy steel.

To return to qualities producing endurance under alternate stress. A drop forging as it comes from the dies is likely to be in a non-homogeneous condition as the result of the process and at the best, because finished at a relatively high temperature, is likely to possess a very coarse open grain. If intended for a vital part this grain must be refined. It may be perfectly done by proper heat treatment, and it is done habitually by careful operators. The result is a homogeneous piece of metal. No other character of steel is fit to enter the construction of an automobile where it is potentially possible of much harm or much good. Carbon steels should be so treated; alloy steels must be, if fair value for money spent is to be received.

Alloy steels of expensive variety have been put into cars without heat treatment, just to say that they were used. An alloy steel not suitably treated, that is in an annealed or forged state, is little if any better than good open-hearth machine steel in an annealed condition. Its endurance under fatigue test is low. Its elastic limit is low, and its structure as indicated by transverse fracture is bad. Such use of alloy steel is unreasonable and the only additional value obtained for the excess paid as compared with carbon steel is an advertising value.

On the other hand alloy steels suitably chosen and heat-treated have extricated many an engineer from real trouble. A driving shaft, having 60,000 lbs. elastic limit, for example, may have proven weak with good carbon steel. Because of the design of connecting parts a change in dimensions is often practically impossible. A solution is easy with a good 0.30 carbon, 3.5 per cent. nickel steel treated to 90,000 lbs. per sq. inch elastic limit, or if necessary a chrome-nickel of high carbon treated to 150,000 lbs. elastic limit. Such applications of alloys are worth all they cost and are reasonable in every way.

It is the alloy steel that responds best of all steels to heat treatment. Results are obtainable that are nothing short of wonderful. Only recently a tensile strength of 300,000 lbs. per sq. inch has been reached. Coupled with such strength, say 200,000 lbs. per sq. inch, very great ductility is obtainable as indicated by elongation and reduction of area at section of rupture. Too great stress cannot be laid on this last item. It is the best measure, in a tensile test, of the degree of refinement of grain attained by heat treatment. Reduction of area will be slight if the crystals or grains are large. If the grains are large as already stated, endurance under fatigue will be little and endurance is beyond argument the most valuable asset of an automobile subject as it is to shock and vibration at all times, while in motion, and to an extent beyond any other mechanism.

Attention has been called to the relative endurance of 0.10 and 0.40 per cent. carbon steels under fatigue test. Under the same dead load a specimen of 0.30 per cent. carbon, 3.5 per cent. nickel heat-treated will endure several million alternations of a 25,000 lbs. per sq. inch fiber stress, and a specimen of 7.5 per cent. nickel has endured one hundred million without rupture with the fiber stress at about 50,000 lbs. per sq. inch. The tensile tests give no indication of any such difference in endurance unless it be in the reduction of area coupled with a high elastic limit. These figures are always large with good endurance. The reduction of area is a measure of fine grain, so it would seem that this quality may be the most influential in determining endurance.

There is a good chance for theorizing and reasoning along this line. With the theory of cold crystallization set aside, a reasonable cause for breakage must be found Steel may be considered as made up of crystals which interlace and adhere. If a test specimen were made up of crystals whose faces equalled the diameter of the specimen, there would be the exaggerated condition of all adhesion and no interlacing. One cleavage plane extending across the specimen. It is easy to conceive that the separation of surfaces once started would jump at once across the specimen and rupture would occur. There would be only adhesion to overcome. It is equally plain that were the same specimens made up of an infinite number of crystals, that a separation started at the periphery would meet with an interruption before being of finite size; after which a fresh start might recur at another point to meet with similar interruption. In this way an infinite number of starts would be necessary to bring about rupture. In other words there would be no chance for a continuous fracture along any one line or surface, and rupture would be delayed indefinitely.

A fibered piece of steel endures better than one not fibered although both may be of very fine grain. It is easy to conceive that if "fiber" is all the name implies, that an incipient fracture formed in one fiber could not continue across the space between fibers and would thus stop. Wrought-iron breaks under fatigue as in an axle or shaft. The fracture always shows crystals. Is it not possible that a fatigue break can take place only where crystals exist, and that because crystals are at a given section, fracture takes place there?

It is easy to understand how a progressive fracture may proceed along the faces of a series of crystals as in the splitting of granite by means of wedges driven into a row of holes It is not easy to conceive the splitting of good fibrous hickory or elm except with and along the fiber. Splitting across the fiber is impossible there could be no continuous fracture and therefore no rupture.

A fatigue break has been described as "progressive intermolecular rupture." It would seem more probable to be "intercrystalline" inasmuch as the molecules, of a given composition, are doubtless all of a size, regardless of heat treatment or physical treatment. On this theory, heat treatment would cause no difference in behavior under fatigue which would be contrary to fact.

Another phase of fatigue is, that such breaks rarely if ever occur unless strains concentrate at or near one plane or section. If strains be distributed as in a beam of uniform strength, fatigue does not occur. A generous fillet or a taper retards fatigue almost indefinitely. A sharp corner causes it to occur very quickly.

Design and material both play an important part, and the two must be considered simultaneously if good engineering is to be attained. If a design be adequate with poor material, it is folly to buy better. If design be suited for the best, then only such may be used otherwise bending and breaking will occur at once. These statements seem too simple for reiteration, but it is a sad fact that both simple truths are violated in automobile construction.

There is one form of heat treatment as old as the hills, that is little understood by many that have practised it longest, namely, "casehardening." It is easy to turn out coarse or fine grained product. The fine grained is desirable (as in good tool steel), the coarse grain is not, as in burned tool steel. Too few realize that a low grade steel after carbonizing is no longer low grade. It has had money spent on it to improve it and if the low carbon was pure steel; the high carbon exterior, the result of carbonizing, is pure high carbon steel; therefore, good tool steel and must be treated accordingly.

No tool dresser would heat tool steel in boxes for ten hours at a temperature of 1,700 deg. F., then quench in water at that temperature and expect a tool to do good work. Yet this is exactly what is done in many otherwise well regulated plants, and the steel is blamed if the parts so treated are brittle. So treated the crystals are large; the steel is brittle.

If used for ball or roller bearings, the polished surface is friable and crystals spawl out thus starting pits and fractures. Suitable refining treatment improves this condition and makes a success out of a possible failure.

In casehardened parts two qualities of metal are to be dealt with, and the best practice demands treatment that will refine both grades. The interior of two are the original carbon and the exterior a carbonized layer of a higher carbon. The refining temperature of the lower carbon is higher and one treatment must reach this. The other temperature, correct for the high carbon, will not undo the refinement of the lower carbon. Thus by two treatments both qualities are fully refined and the composite structure is a good one. Alloy steels are subject to the same laws, and it is only necessary to be acquainted with the critical points of the various compositions to get the best results.

Transmission gears and main drive bevel gears are successfully made of carbonized steel, both carbon and alloy. The quality selected must be referred to design and duty. The duty of constant mesh gears running in oil is relatively easy if the dimensions be generous. The duty of clashing transmission gears is never easy and may be awful with a dragging clutch or careless manipulation by the car driver, and with clashing taking place under loaded or partially loaded conditions.

With equally good design the bevel driving gears do not need the same or as good steel as the transmission gears. It is common and good practice to make the large bevel gear of good carbon steel and the driving pinion meshing with it of an alloy steel.

The character of the treatment and resulting condition of the steel is of vastly more importance than the composition of the steel used. The best of alloy steel may be so handled in treating as to produce a weak and inferior part. Similarly by the best of treatment good open-hearth machine steel may be so well handled as to make a most excellent main drive pinion or other part.

It is true that the best must be produced for a few designs, but such are much in the minority at this time There has been very little real close designing as yet. Empirical knowledge and data as to available materials are not yet exact. The art of heat-treating is not uniform and wide-spread among producers of automobile parts. A liberal margin of safety against uncertainty and non-uniformity is still the rule.

There is one practice in vogue among purchasers of alloy steels that does not seem to be founded on good reason. It is that physical requirements are specified in face of the fact that the steel is to be forged and heat-treated before being used in a car. Its final condition may bear no relation to its purchased condition. It may be carbonized for example. If steel be purchased on chemical analysis, the control is sufficient. With a known composition heat treatment may be intelligently directed without reference to original tension test characteristics.

If to be used as purchased, the matter is different and physical characteristics must be known. Elastic limit, reduction of area, elongation and tensile strength, in the order named, are desirable. If these physical tests be demanded then complete chemical analysis must not be. The steel manufacturer cannot produce if tied hand and foot. It is proper to specify chemical analysis as to impurity, that is phosphorus and sulphur, and also as to the dominant elements; nickel, chrome-nickel and so on. Even in these elements, manufacturing tolerances must be allowed. The practice of limiting all elements coupled with physical requirements is wrong and often leads to the absurd situation of specifying an impossibility.

Even at the best, with the one writing the specifications knowing exactly what has been the practice in one steel works; it is not certain that in another works the result would be quite the same. Some works use melting processes, casting methods and forging methods that may easily modify physical characteristics as compared with practices in other works.

With a given quality of automobile in view, the number of grades of steel necessary to construct it is few, namely, a good all-around forging steel, a steel of slightly better quality to be used for gears, a spring steel and a steel suited for the pressed sheet-steel portions of it.

These steels, properly handled and heat-treated, each part for its peculiar duty, will produce a car of very high grade so far as the steel portions are concerned.

The car of extreme design, racing or otherwise, one that has been designed to strip off the last pound of weight, must be handled differently. Such a car is the exception and must be treated accordingly.

If an order be accepted at all under such unfair restrictions, it must be at an advanced price to cover probable difficulties. This simple fact is so well known to the steel producer that it is apparently absurd to state it, but it is not well known by the steel consumer and needs repeating for their benefit.

To sum up, the attempt has been made to indicate that alloy steel is better than plain carbon steel, that is, stronger and more enduring; that the design of some cars is such as to necessitate the use of the strongest alloy steel and that the design of others is such that an alloy steel is superfluous and money wasted.

That steel that is good for one purpose is bad for another and really that the term "good steel" is meaningless unless it be understood "for what." Pure steel, meaning freedom from impurities, means something always. It insures that such steel will give "good" results if the composition is suitable for a purpose and if the steel be treated to develop proper physical characteristics for the duty to be performed. Several steels (compositions), may be available that will perform a given function perfectly if properly selected and treated. No consumer need be tied to one maker, one composition nor one method of treatment. Several of each are always at hand that will give satisfaction. Reasonable use of steels can only be reached along lines as broad as this.—*Journal of the Franklin Institute.*

A British inventor has devised a new standard resistance unit for heavy currents. It consists of a glass tube filled with mercury and fitted with platinum terminals communicating with the mercury. The heat produced by a current passing through the mercury causes the latter to expand and rise in an auxiliary tube of fine bore, graduated in ohms.

Curtiss's Experiments in Rising from the Water

How the Winner of the Scientific American Trophy Developed a Satisfactory Float for His Biplane

DURING the past two years Glenn H. Curtiss, who, more than any other experimenter, has been given to developing the aeroplane for various uses, has experimented with floats for his biplane that would enable it to rise from the surface of the water. Something over a year ago he succeeded in developing a speed of about 20 miles an hour on the water, but this was insufficient to rise from the surface.

At the first try-out, while traveling over the water at high speed, Mr. Curtiss found himself suddenly nearing the shore, and to avoid running aground he turned his horizontal rudder sharply upward, with the result that the machine rose from the water with perfect ease. He soon alighted again, and in the second flight he made a circle and remained in the air a minute and 21 seconds. Two other experimental flights were made the first day, and on January 27th he made a 3½-minute flight and stated, upon alighting, that he found no difficulty in remaining aloft as long as he pleased. The machine showed a speed of 50 miles an hour in the air as against 45 miles an hour when skimming over the surface of the water.

HOISTING THE BIPLANE ABOARD THE "PENNSYLVANIA."

The motor in front and the pilot's seat with its shoulder frame for operating the balancing planes are visible in this picture. Note also the vertical fins below the lower plane at each end and the single screw-like pontoon that floats the aeroplane on the water.

At the beginning of the new year Mr. Curtiss moved to the Pacific Coast and set about endeavoring to develop suitable floats which would make it possible for his machine to rise from the surface of the water. These experiments have been carried on at San Diego, where Mr. Curtiss is instructing several naval and military officers in the art of flying.

In his first experiments on the Pacific Coast Mr. Curtiss followed the successful experiments of this sort made by M. Henri Fabre at Marseilles, France, about a year ago, as far as the design of his floats was concerned. He constructed one large float six feet wide, five feet from front to rear, and one foot thick at its central point, and placed this under the center of the machine. The bottom of this float was perfectly flat and arranged at an incline of 10 or 12 degrees. Some distance forward of the main float, at about the position of the front wheel in the land machine, another float six feet wide, by one foot from front to rear, and six inches deep, was placed; while at the extreme front end of the machine, on a special outrigger, was mounted a small elevating hydroplane six feet wide by eight inches in a fore-and-aft direction, and one and one-half inches thick. This hydroplane was fixed at an angle of about 25 degrees and was intended to lift the front part of the machine. A spray shield was fitted back of it, as shown in the diagram.

The first experiments were made with these new floats on January 26th last; and although they made a considerable disturbance in the water, especially at low speed, the aviator was enabled to get up a speed on the surface of about 45 miles an hour. He found that at as low a rate as ten miles the hydroplanes (which normally were submerged) rose to the surface, while as the speed increased only the rear edges of the two main planes were required to support the machine. The aeroplane readily attained sufficient speed to rise in the air, for as the speed increased and the floats emerged from the water, the head resistance of the floats diminished and there was only the skin friction of the water on a few inches of the rear edge of these floats, plus the air resistance, to be overcome.

Not satisfied with the several floats with which he had attained his first success in rising from the water, Mr. Curtiss immediately constructed a single float 12 feet long by 2 feet in width and 12 inches deep. This float is built of wood and resembles a flat-bottomed boat or scow, the top being covered with canvas to keep the water from getting in. Three feet from the front end the bottom is curved upward forming a bow the full width of the float, while at the same distance from the rear the float slants downward in a similar manner.

This single float is placed under the aeroplane in such a position that the main weight of the machine and aviator is slightly to the rear of the center of the float, which causes the latter to incline upward slightly and thus gives the necessary angle for hydroplaning on the surface of the water. The weight of this new float is but 50 pounds, or less than half as much as that of the two floats that were used before.

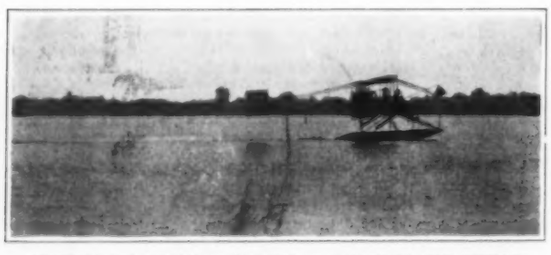
The paint was barely dry on the new float before Mr. Curtiss had it fitted to his machine and gave it a trial. This was done on February 1st and the trial was thoroughly successful. The machine ran over the surface of the water with very much less disturbance than before and rose in the air readily. A glance at the photographs showing the new and the old floats in action will give one an excellent idea of the much less commotion caused by the single scow-shaped float. Besides being much more compact and creating less disturbance, this float or scow can be used for carrying articles or a passenger.

In order to keep the aeroplane from tilting to one side or the other, an inclined stick four feet long and three inches wide, to which is attached on its upper side an inflated rubber tube, is fastened to the front edge of the lower plane at each end. By the use of these props the aeroplane does not tip readily when skimming along the surface, even though the scow-shaped float used is but two feet in width.

After meeting with success with his new float, Mr. Curtiss, on February 17th, made more flights with the motor and propeller placed at the front of his biplane and with his seat placed at the rear of the main planes. The chief of these flights was one which he made from North Island, where he is experimenting, over San Diego harbor to the cruiser "Pennsylvania." He alighted upon the surface close beside the cruiser and his aeroplane was hauled up beside the warship and placed on her deck. Two of our illustrations show the improved machine skimming the surface and Mr. Curtiss landing on the cruiser. In the latter picture an excellent idea of the biplane and float is obtained. The special twin V-finned tail with a vertical fin in the center, and the stabilizing fins running from the lower plane to the inclined props above mentioned, are shown distinctly in this picture, as well as the balancing planes at the rear of the main planes half way between them, and the scow-shaped float beneath. The reversed positions of the motor and aviator's seat is also apparent, but the greatest change is the removal of the front horizontal rudder. For this reason it was possible to raise the machine so close alongside of the cruiser that the aviator could climb aboard. It would seem that this new arrangement of motor and propeller and the doing away with the front rudder was very good for naval work, although Mr. Curtiss himself did not like the arrangement on account of the air from the propeller striking his face and the motor and propeller interfering with his view forward.

After a short visit on the cruiser the aviator was again lowered to the surface in his machine. A sailor started the engine, and Mr. Curtiss flew back to his starting point in short order. The naval authorities were greatly pleased with his demonstration and it is probable that the Navy Department will purchase one of these machines in the near future and continue the instruction of its officers.

After increasing the surface of his biplane Mr. Curtiss on February 24th, took up one of his naval pupils, Lieut. T. G. Ellyson, as a passenger. He made a flight of 1½ miles, rising to a height of 100 feet and flying as slowly as 25 miles an hour, or as fast as 50 miles an hour, at will. Lieut. Ellyson was seated on the pontoon below the aeroplane. He could look down in the water and see bottom at a depth of 25 feet, and he believes submarines can be easily located by flying over the water. The slow speed at which it is possible to fly will make the biplane especially useful for bomb dropping. As we go to press Mr. Curtiss is about to try his machine fitted with wheels and floats as well.



SKIMMING THE SURFACE AT 40 MILES AN HOUR WITH SCOW PONTOON.

THE BIPLANE GATHERING HEADWAY WITH HYDROPLANE FLOATS.

The water remains nearly unruffled as the craft passes over it. Note disturbance caused by the floats compared with that caused by the scow.

THE FIRST FLIGHT OF A BIPLANE FROM WATER.

Problems in Chemical Industry*

By J. T. BAKER

[The writer discusses the difficulties which arise when an attempt is made to apply on a commercial scale the results obtained from laboratory experiments. He is of the opinion that the chemist is best fitted to overcome these difficulties who combines with the scientific mind a certain amount of common sense.]

INDUSTRIAL chemists may well pride themselves upon being engaged in one of the most important and useful branches of the so-called sciences of the present day, and one that requires, in a certain sense, more science in the solution of its problems, than any other.

The question has often occurred to me, however, to what extent is chemistry a science, and is the solution of its problems a purely scientific work. After analyzing the subject carefully, I am led to venture the statement that chemistry, as we understand it, is not a science, in the strict sense of the term, although it cannot be denied that the enormous advance that has been made in the field of chemistry during the past century, is due in a measure at least, to what is known as scientific investigation and the application of scientific principles. Much of the success, however, if not the largest part of it, is due to the application of what is known as common sense, in contradistinction to so-called science.

Some one has defined science as "organized common sense," and this definition, to a certain extent, is true, but the common sense that I refer to is that which is, so to

*The Journal of the Franklin Institute.

speak, unorganized, and follows no given rule, but occasionally arrives at a conclusion in a problem, without any definite reason, except it be on the plea, that all great discoveries are the result of accident.

Taking the definition of science as organized common sense, or to use another expression, as systematized facts, this definition also implies the further use of knowledge thus systematized, and the distinction between a scientific and an unscientific mind, is that the former adheres to a system and applies it, or attempts to apply it to various problems, while the unscientific mind follows no definite line of action, and arrives at results by accident or by good luck at guessing.

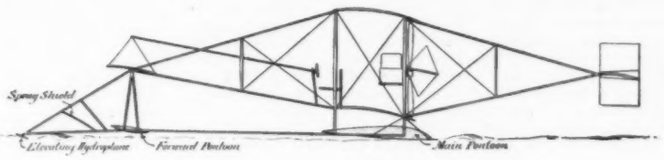


DIAGRAM SHOWING ARRANGEMENT OF HYDROPLANE FLOATS.

On the basis of the above definition of the term science and what it implies, it is evident that the most perfect science will be that in which the systematizing of facts is most complete, and the degree of perfection will be determined by the extent to which the system can be applied and followed. A perfect system is one that is based on a well-defined principle, in which every step is an application of this principle. In this respect it will be found that mathematics is the most perfect system, for here the system is so perfect that its principle can be applied and followed to an unlimited extent. The conclusions reached are absolute and hold good for all time and under all conditions. This is pure mathematics and it is pure science.

In the applied sciences, however, the systematizing of facts is not so complete, and in consequence the systems are not perfect, and can therefore be followed only to a limited extent. The avowed principle of the system and the conclusions reached do not agree, although in some cases the disagreement may be so slight as to be insignificant. Mathematical astronomy affords an example of the most perfect system of applied science, for here, while the systematizing of facts is not absolutely perfect, and consequently the conclusions are not absolute, they are so nearly perfect that the conclusions reached may hold good for thousands of years to come. The variations may be so slight as to be almost infinitesimal, but as long as the conclusions are not absolute, the system is not perfect. In the final analysis the scientific mind fails, and the problem is solved by the unscientific mind, which makes a guess at the result by striking an average.

The absoluteness of pure mathematics as a pure science, and the approximate absoluteness of the science of astronomy, may be explained by the fact that one factor only is taken into consideration in mathematics, namely, that of the relation between objects expressed in symbols, the physical properties of which are entirely ignored, while in astronomy, it is the relation between planetary bodies, the physical and chemical properties of which, however much they may affect the final results, are also practically, if not entirely, ignored.

In fact, as we proceed to explain science in general on this basis, and apply the explanation to the so-called sciences that involve factors whose physical properties must be taken into consideration, it will be found, as the number of factors increases, that the systematizing process becomes more difficult and impossible, while the purity and accuracy of the science decreases accordingly. This will be observed as we pass from astronomy, where the factor is only one, or practically one, to mechanics, physics, chemistry, geology, biology, psychology, etc., the factors of which increase, while their accuracy as sciences decreases in the order named, until we reach sociology and theology, where the factors, consisting entirely of the vagaries of the human mind, become so numerous and antagonistic, that any systematizing whatever is practically impossible, and to these the term science has consequently no application.

It will thus be seen that the term science when applied to the various concrete sciences, has a very limited application, depending upon the number and complexity of the factors involved, and the pursuit of any of the so-called sciences in which the factors become numerous, would soon come to a stand-still, if it did not include the assistance of the unscientific mind; because a multiplicity of factors gives rise to problems, the solution of which is accomplished not so much by science as by empiricism. The tendency of the scientific mind, trained as it is, to look at problems along well-defined lines, in obedience to some system or law, is to ignore conditions and suggestions that do not seem to conform to these laws, with the result that valuable facts are often overlooked. The tendency of the unscientific or practical mind is to go to the other extreme, and ignore laws and systems, and try any suggestion that chances to come along, with the result that while much valuable time and labor may be lost, the loss is fully compensated by a few valuable successes.

I think it is safe to say that it is to the unscientific or practical mind that we are indebted for discoveries in the field of science, for it is only as we deviate from the well-known and familiar paths laid down by the scientific mind, that we stumble upon and discover new facts, and while the unscientific mind stands astonished and at a loss to know what to do with the discovery, it remains for the scientific mind to lay hold of the novelty, and find a place for it in some general system of things. It has been said that the difference between a discoverer and an inventor, is that the discoverer is one who uncovers some new thing which he cannot make use of for lack of knowledge, while the inventor is one who takes the novelty, and by use of his accumulated knowledge, is able to recognize and make use of it, by means of a so-called invention..

While science may be defined as the systematizing of facts, the ultimate object of the system is to arrive at or assume, if necessary, some law that will not only satisfactorily explain the facts, but will also enable us to deduce from the law new facts, or in other words to predict new facts or events. Pure mathematics affords the best example of this ability to predict or make deductions, for its deductions are without limit. Mathematical astronomy affords the next best example, for its deductions, or predictions, relating to the position of planetary bodies, can be made thousands of years in advance.

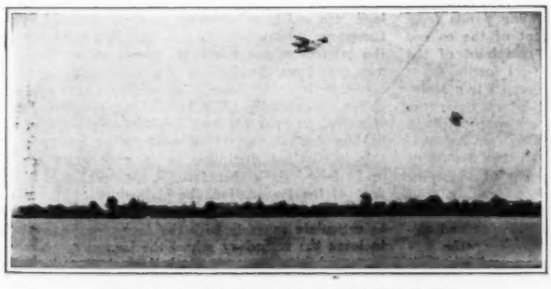
Predictions may therefore be considered a criterion of pure science, and the purity of a so-called science may be measured by its ability to predict, and this depends upon the absoluteness of the law or principle upon which the predictions or deductions are made, for where there is more than one principle involved, the deductions must be more or less antagonistic. In pure mathematics there is but one law or principle—"The whole equals the sum of its parts," and although there may be many corollaries to this law, the deductions are absolute and there can be no antagonism. In astronomy also, there is practically but one law or principle, the law of gravitation, expressed in mathematical terms, and the deductions or predictions therefrom are almost, if not quite absolute. The absoluteness of a principle implies absolute consistency of its application, for any deviation therefrom must necessarily involve the application of other principles. Pure science therefore is a system that involves an absolute principle and absolute consistency in its application.

Now with this understanding of what constitutes pure science, let us turn to the so-called science of chemistry—does it involve but one law or principle, and do we or can we consistently apply this law to the various problems encountered?

Up to the time of Dalton it is well known that the study of chemistry was in a more or less chaotic condition, but after Dalton annunciated his so-called "Atomic Theory," and the same was generally accepted as a working basis, if not as a fundamental law of nature, chemistry became known as a science. Why? Because here was a fundamental law or principle that was considered absolute, and could be consistently applied, with the result that absolute deductions could be made upon the strength of it, and new facts or events could be predicted. Thus we can predict that if the atomic proportions of Cl and H are as 35 to 1, then 35 parts of Cl combined with 1 part of H will produce 36 parts of HCl whether we take grains, pounds or tons of the materials. We can predict that whatever quantities we can combine in chemical affinity, we shall find the same quantities in the resulting compound, and in doing so we have predicted a new fact or law known as the law of the "Conservation of Matter." By a combination of various laws deduced from the fundamental law, we get the law known as the "Periodic Law," from which we can predict new and heretofore unknown elements.

In so far therefore as the law of the Atomic Theory is applied in making deductions therefrom, and in predicting new facts, to that extent, we may honestly say that chemistry is a pure science.. But in chemical investigation, in research work, and in chemical industry, etc., do we or can we apply this law to existing conditions and to the problems that confront us? Working on a small scale, where the only object is the demonstration of the law, the application may so closely approximate the law, as to warrant us in saying, on the basis of probability, that the law is applicable, but when the law is applied on a larger scale, as must be the case in chemical industry, its limitations become very apparent. It would be difficult if not impossible to mention a single instance, where it is not necessary to alter calculations based upon deductions from the law, in order to obtain satisfactory results.. Even the atomic weights, upon the application of which the law is based, are not absolute, and it is therefore self-evident that any deductions therefrom cannot be absolute. These slight inaccuracies experienced when working on a small scale are conveniently attributed to "experimental error," but in operations on a larger scale, particularly in chemical industry, the discrepancies are very marked. Just one example will suffice to illustrate the failure of the law in its application—the manufacture of HNO_3 for instance. The law would require the combination of 172 parts of $NaNO_3$ with 98 parts of H_2SO_4, and on a very small scale in the laboratory, these proportions might give results approximately accurate, but on a large scale using cwts. or tons, these proportions will not give accurate results by any means. That is not to say that the combination takes place in any other proportions

REAR VIEW, SHOWING MAIN HYDROPLANE FLOAT USED IN FIRST EXPERIMENT.



CURTISS IN FLIGHT AFTER RISING FROM THE WATER.

SIDE VIEW OF AEROPLANE SHOWING SINGLE PONTOON.

THE FIRST FLIGHT OF A BIPLANE FROM WATER.

than those laid down in the law, but that the proportions required to produce the calculated results, are not the same. Here the deductions of the scientific mind fail, and the unscientific minds steps in and by experimenting and guessing, finally discovers that 95 parts of $NaNO_3$ instead of 172 must be combined with 98 parts of H_2SO_4 to produce satisfactory results. The proportions thus determined upon, may then be accepted, to a certain extent, as a working basis for the use of the so-called scientific mind in working out future problems of a similar character.

Here we see an illustration of the fact above referred to, that discoveries are made by the unscientific or practical mind, while the scientific mind endeavors to systematize the discoveries and thereby formulate laws for future use. Both qualities are generally combined in the same individual in varying degrees and are essential for success in any line of work, for discoveries, unless they can be formulated into some system from which we can make deductions, are useless, while on the other hand deductions alone from a supposed unchangeable law, would soon become obsolete, by reason of its limitations, which are eventually revealed by new discoveries. If we possessed a universal law, deductions therefrom would be without limit, and discoveries which are now made by accident, would appear as a process of evolution. This is the case with pure mathematics in which there are no discoveries, for each new fact is the result of a process of deduction or evolution.

The principle of mathematics, however, as it is generally understood, is not a universal law, and although it is universally applied in all scientific work, it must be remembered that there are other factors that enter into all problems, each of which involves separate and distinct principles, producing in the end an anomalous condition, for where more than one principle is involved, there must necessarily cease to be a principle. In pure science, as for instance pure mathematics, there is but one principle involved, and its application to symbols that have no intrinsic value involves no complex condition, but in the concrete sciences, we have, besides the mathematical factor, other factors, principally physical, chemical, mechanical, and economical, to say nothing of the temperamental known as the "personal equation," all of which render the condition very complex, and the application of an absolute law, unless it be universal, impossible. This is particularly the case in connection with our so-called science of chemistry, for the application of its principles involves all of the above extraneous factors, and although they may be reduced to a minimum by the use of delicately adjusted appliances in connection with investigation work, they are always present to interfere with the complete application of the principle.

The question, therefore, "Is chemistry a science?" if we answer it on the basis of the definition of science as "organized common sense," by which we mean a system involving an absolute principle from which we can make absolute deduction, must be answered in the negative, for as we have seen, our deductions at best are only approximate, and in the most important branch of chemical work, industrial chemistry, its application is more or less a total failure. While it may be true that chemistry acquires the distinction of being called a science after the acceptance of Dalton's atomic theory as a working basis, it cannot be claimed that the enormous advance since made in the field of chemistry is due to the application of this theory, since in practical work we do not actually apply it at all. Advancement is due rather to the inspiration that this theory affords, by establishing a definite goal towards which concerted action may be directed, for it is concerted action and unity of purpose among workers along any particular line, that produce results.

That chemistry is not a pure science, does not, however, imply that it is to be deposed from its position of importance among other so-called sciences, for the same condition applies to them all with the result that we have no real science except pure mathematics. Pure mathematics, however, limited as it is to symbols only, would be useless if it had no application to concrete things in connection with the other so-called sciences, and as this application is not perfect, owing to other factors present, we must conclude that there is no such thing as a perfect science defined as "organized common sense."

To escape from this apparent absurdity, we are compelled to change our definition of the term science, and devise a definition that will apply to existing conditions. Instead of defining science as "organized common sense," we might define it as "practical common sense," or as Prof. James might call it, "pragmatic" common sense, that is to say, the sense that makes use of anything that works. All sense is common sense, and the so-called organized common sense or science is judged, not by the degree of perfection of its system, however necessary perfection may be as a criterion of pure science, but rather, is it judged by practical consideration, by results.

Human nature is practical if it is anything, and a theory, no matter how profound it may be, even if it be a theory of life, has little interest for us if it is not practical. When a new theory is propounded, our first question is not, is the theory true, but, will it work, will it "deliver the goods"; if not, we have no use for it. We judge a theory, or system or any line of work, solely by practical considerations, and these practical considerations are not academic but humanistic, not scholarly attainments, but things that add to the happiness and comfort of mankind.

Human nature looks for immediate returns, and of all lines of work, can there be found one that gives for labor expended more satisfactory returns than that which is included under the name of chemistry. It is ostensibly based on a fundamental principle, and although the results may not accord with the principle, the results are, nevertheless, approximately what we are looking for, which is achievement, and even if incomplete, we are satisfied to call it a science. If its field of operations were confined to purely scientific work, where the only object is the relations between hypothetical atoms, its usefulness would be so limited, that its work would be no more productive of happiness than astronomy, which deals with the far distant planets, or the study of metaphysics, that deals with things transcendental.

In fact the field of operations open to chemistry is unlimited, and there is no important line of practical work, in which mankind is interested, that is not in some way related to chemistry. On the other hand, the field of practical chemistry is not limited to so-called relations, but includes within its applications many conditions that are not strictly speaking chemical at all, but mechanical, physical, geological, biological and even psychological. From a practical point of view we might say that chemistry is the science of all sciences, for it seems to include them all in one great whole. From determining the elements of the stars, down to analyzing our foods; from steel making to farming, chemistry is an important factor, without the assistance of which no industry can hope to succeed. Consequently its problems, which we started out to discuss, are of a most varied character, and their solution requires not only a knowledge of chemistry, but a thorough knowledge of all the other concrete sciences combined, and most of all an appreciation of the fact that success is counted not by the profoundness of a theory, but by practical attainments. Chemistry as a science, is as simple in its operations as the multiplication table, and involves no greater problems because its application is confined to symbols, that give rise to no counteracting conditions. Real problems arise when application is made to concrete things, that involve not only chemical conditions, but physical, mechanical, economical, temperamental, etc. Temperature, concentration, and so-called "mass action," form, size and construction of implements and utensils employed are all factors that must be harmonized and systematized, and this harmonizing process is what constitutes the problems of chemistry, problems that no scientific mind alone, much less, a purely chemical mind can solve. They are solved only by the broad, common sense, "pragmatic" mind, that is fortified with a knowledge of things in general, and often by the mind that boasts of no knowledge whatever, for as is sometimes the case, problems are solved by an ignorant mind, because unhampered and unprejudiced by preconceived laws, whose supposed fixedness often interferes with freedom of thought.

Just where to draw the line that distinguishes a chemist from another worker, is a difficult, if not impossible task, for if we define a chemist, as one who is engaged in solving problems in the field covered by chemistry, an industrial plant, for instance, then we must include every individual connected with the plant, from the officers down to the common laborer, for each, in his own sphere, is engaged in working out some problem connected with the industry. Consequently, a chemist, an industrial chemist in particular, and all chemists are supposed to be industrial in some capacity, is one whose occupation is that of solving problems arising primarily out of the chemical changes that are constantly taking place in the material universe, but which ultimately embrace every condition that contributes to the material happiness and comfort of mankind. In fact his occupation is philosophical rather than scientific, for instead of looking at things from a scientific point of view, that is from a fixed and limited principle, he learns to look at them from all points of view, which is the philosophical view.

It has been said that "to gain an education is to cultivate an attitude of mind," that is to learn not merely to look at things, but to learn how to look at them. To merely look at things, is to look at them from one point of view, which results in narrow-mindedness, prejudice and bigotry, while the philosophical view cultivates a broad-minded, altruistic attitude of mind, and is productive of the greatest success and the greatest good to mankind.

This is a point that might well be impressed upon chemical students, lest they become deluded with the idea, gathered from their study of the theory of chemistry, that problems can be solved by the application of fixed principles and unchanged laws, unconscious of the fact that their solution is in the end accomplished by adjusting and harmonizing conditions that are antagonistic and incompatible with any fixed principle that may be laid down in a text-book. Instructors in the natural sciences are too prone to impress upon their scholars the absoluteness of the laws of nature, without taking the necessary precaution of drawing a distinction between theory and practice, between science as organized common sense, and science as practical common sense. The most successful chemist is the one who combines a well-balanced amount of both the scientific and the practical mind, for the problems that will confront him quire for their solution the broadest possible attitude of mind. Even those who have had many years of experience, are sometimes liable to be too scientific and to rely too much upon scientific deductions, as for instance when we have worked out some method to approximate perfection on a small scale and then make an attempt to apply it on a larger scale, only to meet with failure and financial loss, because some unforseen factor has arisen that intereferes with the operation.

Summary of the Fifth Annual Report of the Carnegie Foundation

THE fifth annual report of the president of the Carnegie Foundation covers the year ending September 30th, 1910. The report is divided into two parts. Part I pertains to the current business of the year; Part II is a discussion of the Relation of the College and the Secondary School.

The report shows that the trustees had in hand at the end of the year funds amounting to $11,114,056.86, consisting of the original gift of $10,000,000 par value of five per cent bonds and one million accumulated surplus. The income for the year was $543,881.20. During the year 64 retiring allowances were granted, of which 46 were in accepted institutions and 18 in institutions not on the accepted list. During the year 23 pensioners died.

Among distinguished teachers who retired during the year were Professor Burt G. Wilder, of Cornell; Dean Van Amringe and Professor Chandler, of Columbia, both well advanced in years and in academic honors; Professor George L. Goodale, the famous botanist of Harvard; Professor Osborne of the Massachusetts Institute of Technology, who has taught mathematics in that institution since its foundation; Chancellor MacCracken, of New York University; President Seelye, of Smith College, and Professor Calvin M. Woodward, of Washington University, St. Louis. These distinguished men average in age seventy-two years, and illustrate how well the vigor and influence of the scholar can be continued to a ripe maturity.

There were admitted to the accepted list during the year the University of California, the joint institutions of the State of Indiana—Indiana University and Purdue University—and Wesleyan University, the last named a college.

In the first part of the report the president of the Foundation follows up the bulletin on Medical Education by a paper on the Relation of the University to the Medical School, in which he calls attention to the responsibility attaching to any college or university which undertakes medical education.

The second part of the report is a careful attempt to state the existing causes of friction between the secondary school and the college, and the loss of educational efficiency in the present methods of bringing pupils from the school to the college. The complaint of the college against the secondary school and the complaint of the secondary school against the college are set forth.

An extremely interesting part of the report is a statement of the observations of Oxford tutors upon the preparation of the Rhodes Scholars. The strong points in the American boy's preparation are readily seen by these trained teachers, and the weaknesses which they find point directly to the superficiality and diffusion of the work done in the American secondary school and college.

The president of the Foundation urges that this whole question be approached by secondary school men and college men in a spirit of co-operation. Neither the certificate method of admission nor the piecemeal examination method have in his opinion solved the problem. He urges that the college must find a solution which will test better than the certificate or the piecemeal examination the fundamental qualities of the student, and which will at the same time leave to the high school a larger measure of freedom. He recommends a combination of certificate and examinations, the latter of a simple and elementary character, but calling for a high quality of performance without which the candidate will not be admitted. For example, under this plan the boy who cannot write good idiomatic English would not be admitted to college at all, but would be sent back to the secondary school. The entrance requirements recently adopted at Harvard are quite in line with these recommendations. The president of the Foundation urges a co-operation between the secondary school and the college, not as unrelated institutions, but as two parts of a common system of education. He argues that the interest of the great mass of high school students must not be sacrificed to the interest of the minority who are looking toward college. He insists on a larger measure of freedom for the secondary school, but on the other hand he argues that the interest of the boy who goes to college and the boy who goes from the high school into business are alike conserved by learning a few things well, not by learning many things superficially. The boy who has obtained such intellectual discipline is a fit candidate for college, whether he has studied one set of subjects or another; without this intellectual discipline he is unfit alike for college or business. It is therefore, in the opinion of the president of the Foundation, the plain duty of the college, at the present stage of American educational development, to articulate squarely with the four-year high school and to leave the secondary school the largest freedom so that it may educate boys, not coach them; but at the same time to require of the candidates for admission tests which rest upon high performance in the elementary studies and which mean mastery of the fundamentals. In such a program lies the hope of scholarly betterment and of civic efficiency for both college and high school.

On the 28th of April the railroads of Russia will pass under the control of the Imperial Russian Technical Society. This day also marks the opening of an international exposition in St. Petersburg devoted particularly to the application of electricity to railroad service.

The Gold Dredging Industry

Old and New Fields for the Dredger

By Charles Janin

IT is the contention of most engineers and operators familiar with the conditions, and is undoubtedly true to a great extent, that the limits of dredging areas in California have already been fairly well defined, and that the greater portion of the field is controlled by the large interests. Other engineers are more optimistic and believe that tracts which have previously been passed over, or reported on unfavorably, when prospected some years ago, still hold possibilities for the future. With the great advance made in the industry and the development of the modern dredge, from the earlier successful boats with their 600 cubic yards per day capacity, to the boats with 16-foot buckets and the estimated capacity of 300,000 cubic yards per month, and the reduction of working costs, under favorable conditions, to less than 3 cents per cubic yard, it is obvious that areas which a few years ago were considered too low grade to equip with a dredge will, under present conditions, again attract the attention of those interested in the dredging industry.

In Alaska there is a growing demand for dredges of the smaller class, having 2½ to 7 cubic foot buckets, a number of which have been installed in the last year and several of which are planned for 1911. In addition to these smaller boats, the Far North can boast of one of the largest dredges yet constructed, a Marion 16-foot bucket dredge installed on the Boyle concession in the season of 1910. This boat has a total weight of 900 tons and will dig approximately 10,000 cubic yards per day. On this same property, a Marion 7-foot bucket boat has been successfully working since 1906 and is still in good condition; for the past season it is said to have averaged 3,700 cubic yards per day.

Besides the possibility for new dredging areas in California, and other western states and in Alaska, the attention of dredge operators has been attracted to the many opportunities for the installation of dredges in foreign countries. Much interest has been manifested in Siberia of late, and a number of American engineers have been engaged during the past year in the examination of Siberian gravel properties. A number, if not all, of these examinations, resulted unfavorably, some on account of the low grade of the gravel, others because of severe business conditions or exorbitant prices imposed by the owners. However, there is no question that, so far as operating conditions are concerned, there are areas of gravel in Siberia that can be profitably worked. Recent reports from the dredges operating in Siberia show an increased working efficiency, both in the yardage handled and the percentage of gold recovered per dredge.

Recent engagements of experienced engineers for West Africa indicate that it is being more seriously considered as an attractive field for dredging investments. Some of the first dredges there, as in other fields, were failures, but the employment of competent men is the first step toward obtaining reliable knowledge of existing economic conditions, and securing the installation of suitable dredges when they are warranted. This practice, if more often followed, would save investors much money and give a far better tone to the mining business in general.

It may be said that the majority of dredges placed in South America have been unprofitable. This has been due, in part, to a failure to recognize, or to properly appreciate, the difficulties of installing and operating a dredge under the conditions existing in South American countries, and in part to equipping a property with unsuitable dredges on ground the value of which was optimistically guessed at rather than determined by careful sampling.

The most important dredging work in South America is that on the property controlled by the Oroville Dredging, Ltd., on the Nichi River, in Colombia. The area was carefully examined by capable engineers, and is probably the first South American property to be drilled and prospected in the systematic manner in which such work is done in California. Over 300 acres were proved to be profitable dredging ground. The company has a concession of 22,000 acres, the greater portion of which has not yet been prospected. A hydro-electric plant has been built and an 8½-cubic foot bucket dredge (California type), with steel hull, will be built.

In French Guiana, dredging has been tried so far on three rivers only, the Curcibo, the Sparwin and the Lizard. Three new dredges are in course of construction in those places, an indication that the first results, either in dredging or in prospecting, have been encouraging. There are in French Guiana other rivers equally rich. According to the latest reports, a new dredge operating in Roche Creek, carefully prospected in 1908, has given an output of 8 kilogrammes in March and 10 kilogrammes in April, 1910 (1 kilogramme of this gold is worth about $500). Experiments extending over a period of six months were made with an English dredge of 1,000 cubic meters estimated capacity a day, but which, owing to difficulties of operation, was unable to wash more than from 300 to 400 cubic m. in 24 hours. These experiments are said to have demonstrated that the cost of operation in handling this amount of gravel was from 36 to 42 cents per cubic yard.

An entertaining account of the "Goldfields of French Guiana," by Albert Bordeaux, from which the above paragraph was abstracted, appears in the Trans. Amer. Inst. Min. Eng. for November, 1910.

In British Guiana, dredges are successfully operated where the gravel is much lower in gold content than that of French Guiana. It might be that better results could be obtained in French Guiana by employing convict labor, but thus far experiments in this direction have been far from encouraging; another attempt is to be made on a placer near S. Jean du Maroni.

In Dutch Guiana, gold dredging has been carried on along the Saramaca and Marowijne rivers with small Holland-built dredges.

In Mexico, several gravel areas have at times attracted attention. A dredge was installed at Suaqui Grande, Sonora, some years ago, but was not a success. Other places in Sonora along the Yaqui River, near Tonichi and San Antonio, were prospected with Keystone drills with indifferent results. A prospecting party is now drilling at the latter place, but reports from it are not encouraging. The dry placers of Altar have been brought into prominence recently by the success of the Quenner "dry-washing" machine. In Sinaloa there are places where it is claimed that the ground could be profitably dredged. The present outlook for gold dredging in Mexico, however, is not brilliant.

Among other fields that may be mentioned as offering possibilities for gold dredging are Korea, China, and the Philippine Islands. In Korea tests have been made of gravel areas and it has recently been reported that a dredge is to be erected. In China there has been no dredging, but engineers consider that there are areas in the northeastern part which are worthy of investigation. The only successful dredging in the Philippine Islands has been carried on in the Paracale district, which is situated in the northern part of the province of Ambos Camarines on the eastern coast of the island of Luzon. It has been described in "The Mineral Resources of the Philippine Islands," published by the Division of Mines of the Bureau of Science. The placer ground in the vicinity of Paracale generally consists of about four or five meters of barren clay mixed with organic matter overlying a varying amount of gray clay carrying small quantities of gold. Below this is an irregular layer of sand and quartz pebbles, in places showing large amounts of free gold. Dredging operations have been carried on by the Paracale Gold Dredging Co., a New Zealand corporation; the Stanley-Paracale Co., whose dredge is at present shut down, and the Philippine Gold Dredging Co., which bought a dredge originally erected on the island of Masbate. This last dredge was found unsuited to the ground on the Paracale River, and was again moved, this time to the Malaguit, where it is said to be successfully worked.

The Paracale River is really an arm of the sea, with a tide rise and fall of some 5 or 6 feet. The flat in which it runs is perhaps a mile wide near the mouth. It continues about the same width for a mile or more, and then spreads out into smaller flats with ranges of hills between. The total area available for dredging in this flat is estimated at 1,300 acres. The average depth is 30 to 40 feet on the lower river; but higher, where the Stanley dredge is working, the depth is considerably less. The Malaguit River, which flows into the Pacific not far from the Paracale, has been prospected with hand drills. There is a much larger percentage of gravel and heavy material there than on the Paracale. Several other streams in the same district have been prospected to some extent, with results not altogether favorable. Low hills and ridges divide the tidewater streams, and, except where cleared by the natives for growing hemp, are covered with heavy timber and a dense undergrowth, so that prospecting is difficult.

In Burma there are numerous gravel areas, some of which have been worked for generations by the Burmese, who employed a rude method of ground sluicing. A number of these areas have been more or less thoroughly prospected, and several dredges have been built, a number of which were failures. According to J. Malcolm Maclaren, in "Gold, Its Geological Occurrence and Geographical Distribution":

"Of all Burma's numerous auriferous alluvial deposits, none has been considered worthy of extended trial except those owned by the Burma Gold Dredging Co., above Myitkyina. There three dredges were at work in 1907 with results considered so satisfactory that a fourth dredge of greater capacity was being built."

Figures for the past year are not at present obtainable, but according to an article in *The Mining Journal*, in November, 1909, these three dredges worked six days a week for an average of 46 weeks and turned over a total of 1,918,000 cubic yards for the year, with a total recovery of £32,000 ($155,520), or 8 cents per cubic yard. The operating cost, including management, is given at 3½ cents per cubic yard. It is possible that dredges will be placed on other properties; a California type, Bucyrus, boat, has in fact been ordered by the Mewaing Gold Co., Ltd.

In Japan, according to a report recently issued by the Bureau of Mines,

"from early times many placer workings have been carried on in the river beds or terraces along the river sides in the districts of Kesen, Wakuya, Hayakawa, Abekawa, Yoshinogawa, etc. Recently they have begun to be worked in many localities in the Hokkaido, and the River Kilung in Formosa. Up to the present time, only the surface placers have received attention, for which reason no gold, dredging or underground working has been attempted. The largest nugget ever found in Japan weighed only 27.1 ounces, and was found in the gold-bearing gravel at Yesashi. The greater part of these deposits are in the Alluvium, while a few of them are discovered in the Diluvium, yet we never find any Tertiary placers."

In tropical countries there are many drawbacks that should be thoroughly understood by anyone purposing to invest in mining properties. Often rough mule trails are the only means of entering a district and the transportation of heavy machinery would be impossible until some kind of a road was built. Attempts to sectionalize dredges have not been as successful as with other classes of mining machinery. In Guiana the only means for transportation of machinery along the rivers is by canoe. One dredge failed to reach its destination because the hull pieces were too large to be taken over the first rapids. They are still to be seen along the trail. The attempt was made to remedy this loss by building a wooden hull on the ground, but in that climate insects and worms destroy wood in a short time. The next hull ordered was made in smaller pieces.

Climatic conditions in the tropics are generally trying; the heavy rainstorms during the long wet seasons and malaria and beri-beri are to be contended with. The inefficiency of native labor is also a serious matter, though in some cases it has been possible to instruct natives to operate a dredge, with a white overseer in control. There is always difficulty in securing and maintaining an efficient and honest staff of white labor, so far from home, and it is generally necessary to have a reserve corps to fall back on when occasion requires.

One engineer, who has some interesting figures from an extensive examination in Colombia, mentions that his white assistants were incapacitated 16 2/3 per cent of the time from sickness. On another trip the young engineer in charge contracted a fever which proved fatal. In foreign countries, as elsewhere, in making investments in dredging, much money may be saved, and disappointment avoided, if prospective investors will insist upon having reports by experienced engineers rather than listening to the advice of optimistic incompetents, and going blindly into enterprises that, to be an economic success, require experience and good judgment in every phase of the work.

* Condensed from an article in the *Mining and Scientific Press* of Dec. 31st, 1910.

The Block Signal on the New Paris Subway

THE block signal system used on the new Paris north-south subway, introduces an improvement over the former practice. When a train is stopped in the tunnel, all the other trains on the line are stopped and also in the tunnel. It is desired to prevent this and to allow the other trains to reach the next station before stopping. A special green light known as "permissive signal," allows of doing this. At the entrance of the block there are three signal lights, white, green and red, and at the end, white and a double red light. When the train leaves the station, it automatically throws on the double red outgoing signal, so that if a train comes in the rear it finds the entrance signal at green (permissive) which shows that it can enter the station, but that there is a train in front of it within the tunnel. The rear train enters the station but is stopped there by the double red outgoing light. When the fore train reaches another station it annuls one of the red lights. The back train is still stopped by this red light, but it knows that the fore train has now reached a station. When the front train leaves its station it puts on the white light for clear track as usual. The green light is here used exceptionally as a "permissive signal" so as to allow the rear train to come into the station, but it can go no farther, as it is stopped by the double red light or the single red. Thus the principle is kept of separating two trains by two red lights, but the two are now condensed on the same outgoing signal. By this method all the trains can enter the stations in front of them, even if one should be blocked in the tunnel, and the passengers can be discharged. On the old system when one train was stopped in the tunnel, all the others are likewise stopped and could not enter the stations.

Electric Works for the Production of Cast and Forged Steel

AN electric steel works has been installed on a large scale at Dommeldange, Luxemburg. It produces cast and forged steel and is now running at full production. Three blast furnaces give 330 tons of iron per day. For the steel process, Wellmann-Talbot heating furnaces and Kjellin electric furnaces are used. Two of the latter are now in operation for use on single-phase current, and a third furnace is adapted for three-phase current. The plant makes extensive use of blast furnace gas for running gas engines and also as boiler fuel. Steam turbines are run from the boilers. Especially noteworthy are the large Augsburg gas engines which are of special design for use in operating on the blast furnace-gas. This is first passed through scrubbers before going to the engines.

The Famous Astronomical Clock of Venice

The Church of St. Mark and the Torre dell Orologio

By Charles A. Brassler

THE attention of the entire civilized world was recently attracted to Venice, the "white swan of cities," by the news that the Campanile, one of the architectural attractions of the renowned plaza of St. Mark, which collapsed, and was a heap of ruins in 1902, has been successfully rebuilt. The disaster was attributed to the insecurity of the foundations, in the swampy bottom, and it was feared that other historical structures, fronting on the show place, were threatened with a similar fate. The fact that this would be regarded as a catastrophe of world-wide significance induced the Italian government to investigate the conditions of these historical structures, which include the Doge's palace, the Church of St. Mark, and the Torre dell Orologio (clock tower), so called from its being the location of the famous Astronomical Clock of Venice.

This last named building, which is seventy feet in height, and is of solid white marble with decorations consisting of panels of colored Carrara marble and mosaics of gold and lapis-lazuli, was erected for business purposes as early as the fifteenth century, the archway in the center giving access to the *Mercevia*, the commercial center of Venice, where the principal stores are to be found and the best retail trade is carried on. Pietro Lombardo was the architect of the tower, which was built in 1494; the wings on each side, also built in the style of his school, were not erected until the beginning of the sixteenth century.

The first clock installed in the tower was made by Giovan Paolo Rinaldi, of Reggio, and Gian Carlo, his son, but in 1750 it was badly damaged by lightning, and Ferracina, of Bassano, reconstructed it in 1775. Evelyn in his memoirs, under date 1645, evidently refers to the first clock when he describes it as next to that at Strasburg for its many movements, some of which he mentions, his description indicating that many of the features of the original clock have been embodied in the present timepiece.

One of our illustrations shows the great dial of the clock and the automata with which it is surmounted. The dial bears on its outer circle the hours from 1 to 12, in Arabic figures, twice repeated, making the twenty-four hours used in the Italian system of dividing time, but subdivided to make them comprehensible to those accustomed to other methods of division. The inner circle shows the signs of the zodiac, and revolves at such speed as to show the months in their relation to the period. The hour is indicated by the single hand, there being but one, in accordance with the old system of clock construction. The body of this hand is concealed behind the center of the clock, only the point, in the form of a blazing sun, showing beyond the groove between the first and second circles in which it travels around to point the hours. The center of the clock is of black enamel, spangled with golden stars to represent the heavens. Its center is occupied by a golden sun, around which a globe, half black, half gilt, makes a complete revolution in twenty-nine and a half days, reproducing the phases of the moon.

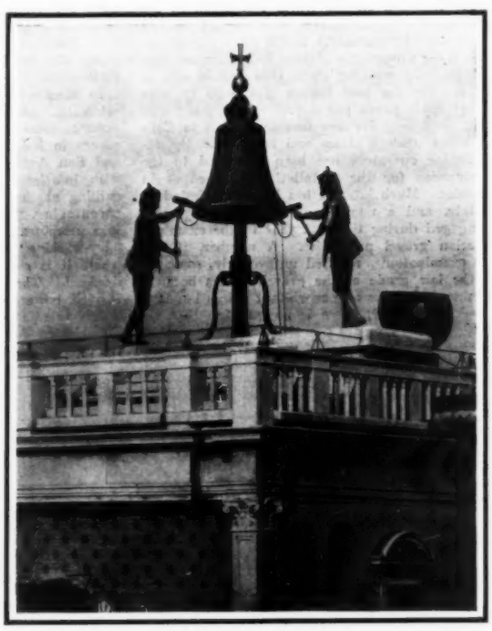
Projecting from the front of the tower above the clock is a balcony, in the center of which sits the Virgin Mary enthroned, a gilded figure, on a background of blue and gilded lattice patterns, holding the infant Jesus on her knee, the figures being flanked by two doors, overlaid with gilded work. Four times a day the doors open and a procession makes its appearance from the door on the right, first an angel blowing on a golden trumpet, then in turn the three kings or wise men from the East—Melchoir, Caspar and Balthasar. Each in passing raises his hand and bows his head, in salutation of the mother of God, enters the door on the left and disappears, the doors closing after the last figure has entered. The procession moves before the Virgin at three, six, nine, and twelve o'clock, and our special photograph showing this portion was taken at the moment when they were passing in front of the throne. On a console above the canopy under which the Virgin sits, is a massive figure in bronze of the winged lion of St. Mark. Surmounting the tower are two bronze figures of Moors—the "bronze giants of Venice"—who strike hours and quarters on two large bells, hung one within the other.

It is related of these figures that on one occasion, something having gone wrong with the striking mechanisms, an attendant went up to investigate. Incautiously, he ventured too near the hammer of one of the giants as it came into action, was struck on the head and hurled to death on the pavement of the plaza. Our photograph shows the figures outlined against the sky in the act of striking the bells.

At the Franco-British Exhibition, held a short time since in London, a model of the old clock with the tower, twelve feet in height and closely following its construction as to materials, etc., was exhibited. It was beautifully executed and reproduced exactly the movements of the celebrated clock.

It is to be hoped that every precaution will be taken by the proper officials to ascertain whether there is really any risk of further damage to the buildings grouped about the square of St. Mark of the nature that resulted in the destruction of the Campanile. The world can ill afford to lose such specimens of the mechanical skill and artistic taste of bygone generations as the clock tower we have just described, and the remaining edifices that make the Plaza of St. Mark in the city of the Doges an object of interest to artistic pilgrims and students of human progress from all over the world.

THE CLOCK JUST AT THE MOMENT WHEN THE THREE WISE MEN OF THE EAST ARE PASSING BEFORE THE VIRGIN AND INFANT



THE GIANT BRONZE MOORS STRIKING HOURS AND QUARTERS OF THE GREAT VENICE CLOCK OF ST. MARK'S

THE FAMOUS ASTRONOMICAL CLOCK OF VENICE

Gyroscope Rudders for Steadying Aeroplane Flight

NEW experiments have been made in France by M. Girardville in the use of the gyroscope upon aeroplanes for steadying them when in flight. The author carried on experimental work at the Chalais-Meudon military aeronautic establishment near Paris. The gyroscopes used here were constructed by M. Delaporte and the revolving mass weighs 5.8 kilograms (12¾ pounds). The speed of rotation can reach 10,000 to 12,000 revolutions per minute, but it was found that 6000 revolutions was sufficient. In this work it was not sought to use the inertia of the gyroscope directly for the steadying, but the gyroscopes were employed for automatic working of the rudders charged with balancing the aeroplane at each instant. To carry this out, the gyroscopes were placed in a case which could turn by trunnions about an axis perpendicular to the rotation axis of the gyroscope. If the trunnion axis is placed in the direction of moving of the aeroplane, for instance, and if the aeroplane tends to incline upwards or downwards, the gyroscope reacts against this inclination by the movement which it has around the trunnion axis. Such movement is transmitted to the rudder by suitable connection. A first set of tests was made with the gyroscope and the rudder mounted together on a swinging frame like a large balance arm and working from a fixed point. The governor took the wind from the blowing machine used in Colonel Renard's experiments on airship models. Under these conditions, when the balance of the system was disturbed either by shifting movable weights on the arm or by bearing against this arm, it was seen that the rudder worked by the gyroscope gave the equilibrium automatically. A second series of tests was made by transporting the whole to the top of the Eiffel Tower and operating under violent and often irregular winds of 40 to 50 feet per second. The results were identical with the foregoing. It should be remarked that at the beginning of the present work, the tests were hindered by the fact that under the action of the gyroscope rudder, the balance arm swings about its pivot and these movements may be very strong. Such effects were, however, all eliminated by using a dash-pot composed of a flat plate working in a vessel of water. After making the above tests with fixed apparatus, M. Girardville proceeded to try actual flights, and placed gyroscope rudders on aeroplane models, first unmanned and then upon aeroplanes without motors, mounted by an aeronaut, such as were used for simple gliding in former aeroplane work. Such tests showed him that even with small sizes, having but 12 square meters (129.2 square feet) surface, the air reactions on the surface were enough to replace the effect of a dash-pot, so that in air flight there was no oscillation noticed. He made a number of flights, unbalancing the aeroplane by shifting the weight and working in irregular winds, and found that the gyroscope rudder always worked in the desired direction and enough to bring back the equilibrium. At present he is engaged in making experiments with aeroplanes carrying motor at the Vincennes military establishment at Paris, and is having encouraging results. During the first tests the motor operated the gyroscopes by flexible shaft and friction rollers. Since then he adopts another method and secures good results by using an extra helice of small diameter which is placed so as to turn, under the action of the wind from the main aeroplane helice. The small helice thus drives the gyroscope by suitable mechanical movement.

The Pygmy People of Africa

Prof. Starr's Discoveries in the Jungle

By Ethel Claire Randall, Ph.M.

In his Preface to Schweinfurth's "The Heart of Africa," Winwood Reade surmises that the pygmies were the original natives of Africa and that they "may be considered as the scattered remains of an aboriginal population now becoming extinct; and their isolated and sporadic existence bears out the hypothesis"; a supposition corroborated by De Quatrefages, who thinks that formerly these little people "formed populations denser and more continuous, that they have been crowded back, separated, divided, by superior races," and again, "whenever one meets with them to-day one sees them retreating, and often dying out." Keane, in spite of his cut-and-dried table of descent, holds a like view regarding the communities of little people as "all being scattered fragments of a primeval dwarfish race, who are to be regarded as the true autochthones of equatorial Africa." Stanley dwells upon the same thought: "These little people have roamed far and wide. . . . From the Niger banks, with successive waves of large migrants, they have come . . . to pitch their leafy huts in the unknown recesses of the forest." "Their kinsmen are known as Bushmen in Cape Colony, as Watwa in the basin of the Lulungu, as Akka in the Monbuttu, as Balia by the Mabode, as Wambutti in the Ihuru, and as Batwa under the shadows of the Lunae Montes."

Of the tribes going to make up the sum of this common dwarf race in Africa, the bulk of material accumulates about the *Akka*, the *Obongo*, the *Batwa*, and the *Wambutti*, and still another small people, the *Bushmen*, concerning whom much has been said and written by way of contradictory opinion as to their connection with the members of the accepted pygmy race. The first of these, the *Akka*, we are told, appear to occupy a continuous area and to number nine distinct tribes, each with its own chieftain. In comparison with the other races among whom they live, Schweinfurth states that they differ from them in scarcely any particular beyond the matter of height and in the tone of the complexion, which is redder or brighter in shade. He measured six adult males and a boy not yet grown. None exceeded materially a height of four feet ten inches. His statements are verified by those of Marno, Giglioli, Chaillé-Long, and Vossion.

Junker fell in with the *Wochua*, whom he assures us the same as described by Scweinfurth, though they call themselves *Achua* or *Wochua* indifferently in distinction to the name *Akka* or *Tickitikki* given them by the Arabs, and *Affifi*, by the surrounding natives. They are feared by those in their vicinity, and pick and choose which tribe they will live near, avoiding some consistently and neighboring with others whose chiefs frequently engage their help in warfare. Their custom is to horde together in small communities rarely exceeding one hundred individuals; nevertheless, they have made their presence so thoroughly felt in their outskirts that they oftentimes stick an arrow into a bunch of green bananas, whereupon, the owner, not daring to pluck it, leaves that particular cluster to be claimed by them when ripe.

Du Chaillu, in "Equatorial Africa and the Country of the Dwarfs," speaks of a tribe of hunters in the neighborhood of the Niembousi totally unlike the *Ashango*, in whose territory they live. These *Obongo* frequently move from one place to another, always taking care, however, to stay within certain confines. They plant nothing. It is not unusual for them to steal from the *Ashango*, then decamp immediately to some more remote part of the district. Yet, in spite of this, the *Ashango* are kind to the little folk, even appearing to like to have them in the neighborhood, inasmuch as they can get exchange of meat from them for the agricultural products and manufactured articles such as iron implements, cooking utensils, water-jugs and the like. The *Ashango* and the *Obongo*, however, do not intermarry. Their disposal of the dead is curious. The corpse is put into the interior of a hollow tree, found somewhere deep in the forest, and the opening is closed with leaves, branches and earth. Still more interesting is the account vouched for by the *Ashango*, who say that at other times the pygmies turn the current of a running stream in order to make a hole in the river-bed where they may place the body, and having suitably covered it, allow the water to regain its accustomed course. Their dialect presents a mixture of their own original language and of that of the various tribes with whom they have come in contact.

"In Darkest Africa" Stanley makes the statement that there is no evidence of polygamy and every evidence that domestic ties are strong among these little people. Each family has its own hut, a low structure of the shape of an oval figure, cut lengthwise, fashioned of the stalks and leaves of the phrynia. Other huts—those peculiar to the *Wambutti*—are elevated and made in a cone shape running to a sharp point from which emerges a central support projecting above the grass-thatched roof. The huts are usually arranged in a circle with the doors varying from two to three feet in height, facing inward toward a hut in the center occupied by the chief and his family. These miniature villages are planted in the midst of the forest several miles distant from a tribe of agricultural aborigines, and it is not uncommon occurrence for a large clearing occupied by big blacks engaged in tillage of the land to be surrounded at intervals by as many as a dozen communities of pygmies, aggregating in all perhaps two thousand five hundred souls. The approaches to a village are indicated by a series of diamond cuttings in the roots of trees across the track leading to it and at a distance of approximately five hundred yards, while within a hundred yards of the camp, along every trail leading to and from it, is a sentry box large enough to accommodate two persons and with a door facing the track, placed there as a toll-gate for caravans. The occupation of the pygmies is hunting and fishing, and scouting for their agricultural neighbors, who, from the nature of their pursuits, are a settled community. They are keen woodmen. Large game they stalk in bodies and bring down by baiting with hundreds of arrows till it falls. Game smaller or less agile than elephants, buffalo and antelope, are trapped in pits covered lightly with sticks, leaves, and earth, and surmounted by a shed-like structure with the roof suspended from a vine in order that it may fall at the right moment. Animals still smaller than chimpanzee, baboons, etc., and birds, are captured in bow-traps fashioned in such a way as to strangle them. The weapons of the dwarfs are tiny bows, and arrows tipped with metal, sometimes steel, and poisoned, as well as spears, and probably axes, since Stanley noticed that the trees in the vicinity of the pygmy camps were scored with ax cuts. The division of labor is practically that known to every people in the state of barbarism: the women do the cooking, collect the fuel and the provisions, as well as carry the household goods when the camp moves, which it does whenever game becomes scarce in one region; the men employ themselves in making traps for game, nets for fishing, in working iron and steel, in carving ivory, which they cut into fantastic designs for bracelets, anklets and necklaces, and in manufacturing the deadly poison with which they smear the tips of the iron arrow-heads and lay thickly on the splints such as are made from wood.

Stanley relates, further, that he met with two types of dwarfs, the individuals differing from one another in complexion, shape of head and in facial characteristics. "Whether the *Batwa* forms one nation and the *Wambutti* another," he says, "we do not know, but they differ as much from each other as a Turk would from a Scandinavian." He captured one of the dwarfs said to live north of the *Wakuma* country and later four women and a boy, one of whom evidently belonged to the *Akka*, for she had "small, cunning, monkey eyes, close and deeply set. The other four possessed large, round eyes, full and prominent, broad round foreheads and round faces, small hands and feet, with slight prognathism of the jaws, figures well formed, though diminutive, and of a brick tint complexion." The monkey-eyed woman had a remarkable pair of mischievous orbs, protruding lips overhanging her chin, a prominent abdomen, narrow, flat chest, sloping shoulders, long arms, feet turned greatly inwards and very short lower legs, as being fitly characteristic of the link long sought between the average modern humanity and its Darwinian progenitors, and certainly deserving of being classed as an extremely low, degraded, almost a bestial type of human being." One of the women was of perfect proportions and "appeared at first to be but an undersized woman; . . . but when we placed some of our Zanzibar boys of fifteen and sixteen years old by her side, and finally placed a woman of the agricultural aborigines near her, it was clear to everyone that these small creatures were a distinct race."

Others who have discussed the *Batwa* are Dr. Wolf, Mr. Hinde, Mr. Verner and Dr. Starr. A number of the points made by Dr. Wolf have already been mentioned. But their method of drying meat upon stagings over the fire has not been spoken of, nor their disposal of such

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PROF. STARR AND ONE OF THE PYGMIES

cured meat to the large negroes upon set market days held on ground common to the two camps. Dr. Wolf notes the servile position occupied by the dwarfs among their big neighbors, and remarks, finally, that "the bodily forms of the *Batwa* were well developed and entirely made the impression of normal."

Mr. Sidney Langford Hinde emphasizes their skill as bowmen and the deadliness of the poisoned arrows in use by the dwarfs, while Mr. Samuel Phillips Verner adds still further to our knowledge of their manner of life. It was Mr. Verner who, at the instigation of the Louisiana Purchase Exposition, brought a group of *Batwa* from the Congo Free State to St. Louis. His account of this drawfish race is to be found in an article published in the *Atlantic Monthly* for August, 1902, and in his book entitled "Pioneering on the Congo." According to information given by him, the *Batwa* are fishermen as well as huntsmen; they spread their nets, both those for hunting and those for fishing, upon poles under grass sheds; their bows are of a crimson-colored wood strung with rattan fiber, while their arrows are of bamboo, notched at one end, pointed at the other, and coated with the black sticky gum which appears when the roots of a Euphorbia are boiled and pressed; their food ranges from hippopotamus to white ants, including locust, caterpillars —these last dried in the sun—besides all varieties of vegetable produce.

With regard to their habit of hunting monkeys, he tells how the *Batwa* clear half an acre of forest, across which they stretch a net ten by forty feet, and driving the monkeys from their haunts into the clearing, dispatch them easily as they become enmeshed in the snare. Baboon skins are prized for dress, or in the lack of this a yard of palm-fiber cloth. Some women, however, and the children, go unclad. Tattooing is not practised among them and beads, brass and copper wire are unknown, but gay feathers and amulets of bone or the skins of small animals are used for decorative purposes. The older men wear a scant beard. Such details of height and personal appearance as are cited by Mr. Verner practically agree with those listed for all pygmies. A *Bantu* proverb aptly illustrates their mental make-up, "Sharp as a pygmy."

A recent visitor to the pygmy lands is Dr. Frederick Starr, whose paper upon the same people has but recently appeared among "Ethnographic Notes from the Congo Free State: An African Miscellany." Dr. Starr, after a summary of the remarks of Wolf, Hinde, Bateman, Stanley and Verner, proceeds to report of his own contact with these little people that, in addition to the numerous tables of measurements, deals with the structure of the *Batwa* huts, their ways of kindling fire by friction on wood, and their custom of adorning the person by "deeply cut and well-marked temple scarring (of the matting or plaiting patterns)" and by clipping the teeth to blunt points. Although at the commencement of his article Dr. Starr owns to having expected to find in the *Batwa* "typical pygmies" and to "have been in a confused frame of mind regarding them, from . . . first contact with them up till now," and that "What shall we do with the *Batwa*" has been a harrassing question," he concludes, "We believe that the *Batwa* should actually be classed with the true pygmies of the Ituri forest"—a statement strengthened by his elaborate comparison of a pygmy, a dwarf and a *Baluba* boy: "They are larger than we should like, but in type, face expression, character and mode of life, they are the same. Constancy of hunting, absence of agriculture, parasitic relation to large neighbors, shyness and distrust, despised condition, use of the bow and poisoned arrows, adherence to making fire by friction, all point one way. To-day scattered and occurring here and there over a large area, they everywhere appear to have been the original occupants of the country."

One ethnologist divides the African negritos into three branches upon his family tree of the Homo-Ethiopicus: The *Akka*, the *Wochua*, and the *Batwa*—this last branching off into the *Obongo* on the one side and farther along into the fork of the *Hottentots* and the *Bushmen*. But a classification of this nature, even in the light of a review brief as the foregoing, can be seen to argue a somewhat strict division and subdivision not warranted by the information at hand. The names, the number of races, if more than one, much less the course of development or branching of one tribe from another, is by no means clear as Keane's table would give us to understand. Certainly in view of the scarcity of actual scientific knowledge upon the subject, the attempt to prove that "all the tribes of Africa whose proper characteristic is an abnormally low stature belong to one and the self-same race" (Schweinfurth), is of more consequence than a hard-and-fast tabulation of tribes within that generalization of race.

Prof. Van der Waals of Leyden

A Nobel Prize Winner

THE eminent Dutch physicist, Professor Van der Waals of Leyden, who has just received one of the Nobel prizes, is justly celebrated throughout Europe for his contributions to the advancement of science. His name, however, is as yet little known in this country, and this is the more strange because his fame largely rests upon his development and application of a scientific theory first promulgated by an American physicist, W. Gibbs.

A writer in a recent number of *La Nature* gives an interesting *résumé* of Van der Waals' achievements and their basis.

Born at Leyden in 1853, he became celebrated upon the discovery of an equation which permits, better than the formulæ of Rankine and Hirn, the expression of the characteristic relation of fluids, i. e., the relation between specific volume, pressure and temperature. He has shown what expression should be substituted for each gas, in the laws of Mariotte and Gay-Lussac, when we endeavor to approximate reality. To arrive at this he conceived the fecund idea of extending to gases the considerations upon which Laplace founded his theory of capillarity.

The method adopted by the Dutch savant for governing the calculation and combining the results of diverse investigation indicates a remarkable profundity of thought; it is peculiarly attractive to those who study from the philosopher's point of view the genesis of the great theories of modern physics.

Thanks to him the parallelism which has been observed in liquids with respect to certain special properties in definite conditions of temperature has taken on a general character for all fluids, whether liquid or gaseous, and a definite significance.

Thus, as Poincaré observes, the Leyden physicist has given to the words "corresponding states" a precise significance; he has demonstrated that the specific constants of each body disappear in the characteristic equation when we take for units the values corresponding to critical points, and that in corresponding states any two fluids have precisely the same properties.

It may be remarked, as was proved first by Natanson, and afterwards by Prof. Curie, that the theory of corresponding states does not necessarily imply the exactitude of the formula of Van der Waals.

But the man has not contented himself with studying the statics of a simple fluid. He has regarded mixed fluids as compositions of a vast number of particles, and has established an equation characteristic of mixtures, which no longer depends on thermodynamic ideas, as one might suppose, but on mechanical hypotheses. This equation has been made the subject of a critical study by Berthelot. In short, Van der Waals has extended his investigation to abnormal substances, associated or dissociated.

One of his greatest services—a service both to science and to industry—was his appreciation and exploitation of the value of a remarkable treatise published in 1876 by an American physicist, W. Gibbs, on "The Equilibrium of Heterogeneous Substances."

This had remained practically ignored for fifteen years, until Van der Waals called the attention of the scientific world to it. This memoir contained in practically complete form the theory of thermodynamic statics, and the manifold applications of thermodynamics, including notably the liquefaction of gases, are based on a profound study of this work.

If certain biologic researches even lead to conclusions of the highest interest from the point of view of cosmogenic hypotheses upon the cold of space, how many analogies in the immediate domain of applied science would be lacking if we were still ignorant of the famous law of phases and of the idea of eutexia thereto attached by Guthrie. It is the application of this which permits the control and verification of complex facts such as the equilibrium between one or several bodies and the solution which contains them, and, more generally, which allows us to obtain a precise guide in critical investigations of chemical mechanics.

These questions, apparently so theoretical, are moreover of the greatest practical interest.

Just as cryoscopic and tonometric measurements furnish to experimenters the easy solution of delicate problems of hygiene, such as the control of milk or other alimentary substances; just as isotonia plays a more and more important part in medicine and physiology, as is shown in the study of serums; in the same way the law of phases facilitates the study of equilibriums in liquid or solid solutions, such as the complex equilibrium between the salts of sea water, the study of steels and metallic alloys, and the study of petroleums, glasses, cements and hydraulic mortars.

If the physicist finds scientific interest of capital importance in the relation which defines the equilibrium of homogeneous gaseous systems, the engineer finds no less interest in the ability to obtain a precise knowledge of the phenomena of the reduction of minerals in gas furnaces.

Finally the labors of Van der Waals have largely contributed to the establishment of the fact of the existence of a continuous passage of matter from the liquid to the gaseous state—a point as important for the philosopher as for the scientist.

By his penetrating intellect, his exact reasoning, and his bold forecasts justified by later experiment, Van der Waals has won a pre-eminent place among men of science. The bestowal of the Nobel prize upon him will now make known to the enlightened public the name of this theorist whose investigations of the laws of kinetics have been so fertile in applications of industrial importance.

Resistance of Metallic Filament Lamps to Shock

THE employment of metallic filament lamps is rapidly increasing because their consumption of electrical energy is only about one-third that of carbon filament lamps of the same candle-power, while their price has fallen from 80 or 90 cents apiece to 40 or 50 cents. The principal defect of metallic filaments is their fragility. When cold they are easily broken by shock and vibration. The filament itself is in less danger of breakage when heated by the current, but then the same agencies often weld together filaments which are too slack or too near each other. Hence the cost of renewal is large and these lamps cannot be used in railway or trolley cars, or in portable mountings.

For these reasons it is important to determine the degree of sensitiveness to shock possessed by various metallic filament lamps. This has been done by suspending the lamp by a flexible wire and subjecting it to the impact of a rubber-coated leaden bullet which rolls down an inclined track. The force of the impact can be varied by varying the weight of the bullet and the length and inclination of the track.

Dr. E. Liegeand has invented another apparatus for subjecting the filament to a series of shocks, the intensity of which can be regulated. The lamp is fastened on a board *AB* which turns on a hinge at *A* (Fig. 1). The free end *B* of the board is alternately raised by the rotation of the spiral cam *c*, and brought down again by the weight of the lamp and board, assisted by the tension of the spring *R*.

After falling through the distance *h*, determined by the profile of the cam, the board is suddenly arrested by striking the small part of the cam. The intensity of the shock which is thus given to the lamp is determined by the tension of the spring, which can be varied and can be measured with a steel yard. In order to ascertain the number of shocks that the filament can withstand before breaking, an apparatus for counting the number of revolutions is attached to the shaft of the cam, which is turned by an electric motor at the rate of one revolution per second. The key *ab* (Fig. 2) in the circuit of the motor is kept closed while the lamp is burning by the relay *R*,

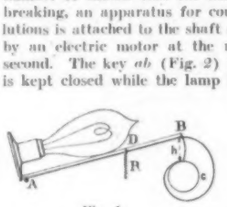

Fig. 1.

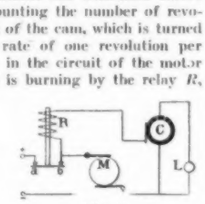

Fig. 2.

Apparatus for Determining the Resistance of Metallic Filament Lamps to Shock.

which is traversed by the lamp current. When the filament breaks the key is opened by a spring, the motor stops and the number of shocks which the lamp has received is indicated by the registering apparatus. In measuring the ability of the filament to resist shock when cold the lamp circuit is closed during only a small fraction of each second, by means of rotary commutator *C*, keyed on the shaft of the cam. The intermittent current thus produced does not greatly heat the filament, but it keeps the motor circuit closed by means of the relay until the filament breaks. The number of shocks required to weld two heated filaments together can be determined by adjusting the relay so that it opens the motor circuit when the resistance of the lamp has been diminished by a certain amount of welding of the filaments.—*Le Génie Civil.*

Invar Wires for Geodesic Work

WIRES of the new non-expansion alloy known as invar have been used for measuring in geodesic work in the Simplon Tunnel and in various scientific expeditions. It is valuable for such uses, as it keeps its length to a very close degree. This metal, it will be remembered, is a nickel-steel alloy with about 34 per cent nickel, and it expands but 1-10 the amount for iron, hence it is coming into use for scientific work. M. C. Guillaume, chief of the Weights and Measures Bureau of Paris, who prepared this alloy, made tests with measuring wires in the basement of the establishment. As a base he used lines drawn on nickel plates incrusted in heavy bronze soles, and these were cemented into the foundation walls, using six measuring marks at 12 feet apart, covering 72 feet of length. He compared the measuring wires directly with this standard, stretching them by heavy weights and pulleys. The wires carry measuring scales attached to their ends. Twelve wires gave almost identical lengths for some years, and any irregularities were found to be mainly due to the expansion of the wall itself. Several years observations allowed of establishing the variations of the wall, which were about two-thirds that of the wires. The wires do not vary, at constan temperature, more than one-millionth, so that "invar" can be quite depended on. He also caused the wires to be expanded with heat up to about 40 degrees change and found that the expansion was very regular and there were no sudden changes. A weight of about 20 pounds was used for stretching. Before this, M. Jäderin brought out a geodesic method using a steel and brass wire. The temperature was deduced from the difference of length, and we thence find the real length. By using invar we need but one wire and use but a rough estimate of the temperature.

Migrating Stars*

Old and New Star-Drift Theories

By J. A. Hardcastle, F.R.A.S.

THE great doctrine of the Fixity of the Stars, has without question exerted a profound influence for good over the imagination of the human race, and the critic who casts it aside as merely an obsolete error only proves his own incapacity for criticism. New conceptions of the stellar universe have arisen to replace it and will doubtless in their turn elevate the responsive mind, but the new must be built on the old, or, to use a truer metaphor, the new must grow out of the old, for intellectual change is no less organic than is our physical growth. From the ancient doctrine of the incorruptibility of the heavens has sprung our own implicit acceptance of the Continuity of Nature, that is to say, the permanence of what we call the Laws of Nature. We need not fear to cast our imagination far into the future and contemplate the possibility of our present views undergoing as radical a change as has been the fate of the Fixity of the Stars, though we may not at present be able to suspect from what direction the new knowledge will come.

It requires, therefore, no defence if we start with the statement that all the stars are moving; we need not rely simply on the *a priori* inconceivability of the contrary, we have the observed fact that the angular distance between any pair of stars is not now the same is it was in the days of Bradley. Nor need we here emphasize the great difficulty of grasping the precise meaning of the words Proper Motion, but it will be obvious that any vagueness as to the technical contents of that phrase will tend to obscure our judgment when we discuss the indications of a sympathetic distribution of proper motions.

These indications were first brought to light by Proctor[1] nearly forty years ago, and to him we owe the origin of the expression "star-drifts." He showed that large groups of stars were animated by a motion across the sky in the same direction and at the same rate, and we must admit the cogency of his argument that this cannot be regarded as accidental. It is, in fact, the fulfillment of the conjecture thrown out a century earlier by William Herschel in "The Philosophical Transactions" of 1783, in a paper entitled "On the Proper Motion of the Sun, etc." The very title of that paper is justification of the word of warning we have just uttered as to the difficulty of keeping quite clear the meaning of the term Proper Motion. Even in a modern syllabus we have the expression "The Proper Motion of the Sun" used to describe its apparent annual motion among the stars, so it is little wonder if the term Proper Motion is a stumbling block to many a beginner. We may perhaps state here once for all that the Proper Motion of a star is the minute change of the *apparent* position which it occupies *with reference to the other stars;* it would require too much space were we to attempt to bring out the full meaning of the words placed in italics.

Proctor's word "drift" has recently been appropriated to a far larger process of which he had no means of knowing. The story of Kapteyn's "Two-Drift Theory" does not enter into the scope of this article, and we need some word which we can use for the much more limited groups to which we now refer. By a happy inspiration Prof. Turner has given them the name of "Migrating Stars,"[2] the various flocks of which need not, of course, be moving in the same direction, but the individual members of each flock will be distinguished by the fact that their motions are parallel and equal. Some of the members of a flock may have passed us—some may be passing on the right, some on the left, while some are still approaching us. Thus we may have to look to all points of the heavens to pick out the components of any one flock.

"Parallelism and equality of motion" are Proctor's words, and we shall presently see how the investigation has carried us now to a point where both those features vanish, and yet the main idea not only remains true, but is vastly enlarged. This is only one more instance of the growth of ideas; the very characteristics by which originally they were defined are discarded, and yet the idea remains.

The best-known cases of equal parallel motion are perhaps the Pleiades and the Great Bear. The arrows in Fig. 1 give by their length and direction the most recent values of the proper motions of those stars. Proctor's discovery is seen at a glance.

Five out of seven are moving in a common progress; the other two obviously do not belong to them. In Fig. 2 we have the arrangement as it will be in 100,000 years, as seen by an observer in the solar system. It may justly be urged with regard to Fig. 2 that we are multiplying observed quantities by at least 1,000, and consequently their errors too. The thousandth part of the length of one of the arrows is a mere point, the uncertainty then of *the direction* of that fraction must surely be very great. The criticism is unquestionably reasonable, and we cannot give the space now to meet it, but we can only state that not only is Fig. 2 accepted by men who are competent to judge of the evidence, but also the much wider inferences to which we shall presently refer are considered sound by leading authorities.

Before continuing the story of these five stars, we will describe another flock of migrants detected by Prof. Lewis Boss in the constellation of Taurus.[3] Prof. Boss, of Albany, will be remembered in the annals of astronomy "for his long-continued work on the positions and proper motions of fundamental stars," to quote the words in which the award of the Gold Medal of the Royal Astronomical Society was made to him in 1905. One of the by-products of his exhaustive and accurate work, which, by the way, was undertaken in order to stake out the 49th parallel of latitude as the boundary between Canada and the United States, was the detection of

Figs. 1 and 2 are drawn from modern values of the proper star motions. Fig. 1 shows the equal parallel movement of five out of seven stars in a common progress, the divergent stars not belonging to the flock. Fig. 2 shows the arrangement as it will be seen by an observer in the solar system in 100,000 years.

the fact that 39 stars in Taurus have proper motions directed toward one spot on the celestial sphere. He gave the name "the convergent" for this point, and it will be readily admitted that it must be "the vanishing point" of a sheaf of parallel tracks. In this case the component stars are scattered over a circular region of the sky so large that six out of the seven stars of the Great Bear could lie on it. As a cluster, therefore, those 39 stars are extremely loose and in no way catch the eye, the individuals being quite faint stars. Let the imagination, however, be projected forward some sixty million years, and the convergence of the tracks will have brought them all on to a smaller space than is now occupied by the Pleiades. If then the cluster will thus condense by mere perspective and the lapse of time, may we not argue backwards and suggest that the compact clusters which we now see might have appeared many million years ago as mere scattered stars apparently quite dissociated, and may we go on to suspect that the actual distances between components of a star-cluster may be comparable to the distance which separates us from the nearest of our stellar neighbors? To have written such words a couple of years ago would have laid one open to the charge of indulging in unguided speculation; this single group of stars has very

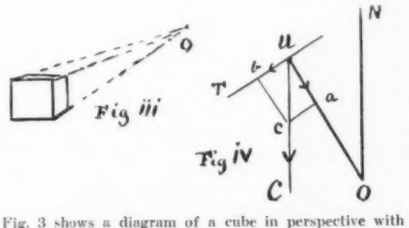

Fig. 3 shows a diagram of a cube in perspective with the vanishing point; Fig. 4, diagram to aid in finding proper motion of star, its velocity, and distance.

greatly widened the limits within which our imaginations may safely play.

In this case, therefore, the parallelism of Proctor's arrows has given place to a convergence of the apparent motions. But the essential feature of parallel motion does not disappear; it is, in fact, brought out more strikingly, and a perspective is added which immensely increases the picturesqueness of the whole conception. The impression that the starry sky is a mere shell or vault is only too easily forced upon us, but here we have a third dimension, the depth of space, illustrated vividly before our imagination.

In Fig. 3, which is the sketch of a cube in perspective with the vanishing point, *O*, of three edges shown, we know that any other line parallel to those edges must, if produced, go through *O;* and for an inverse reason the line of sight from the observer's eye to *O* must be parallel to those edges.

If then one looks at the vanishing point one is looking in a direction parallel to the lines that there vanish. When shafts of light are seen radiating from the sun, we know that they are really all parallel and their common direction is given us by the line from our eye to the sun, although it must be frankly admitted that it requires a real control over the imagination to make it assent to this unimpeachable truth. Now the point *O* corresponds to "the convergent" of Boss's cluster, but supposing all his proper motions had been on the same lines but in the opposite direction, then we should have to call *O* "the divergent," and "the convergent" will be in the diametrically opposite direction from *O*. Suppose a rod pointing at *O*, and suppose we look the other way along it, our line of sight would be parallel still to the motions of the stars and we should be looking at "the convergent." We shall have to use this little proposition in our next example of a flock of migrating stars.

Returning once more to Proctor's five stars, his information only warranted him in asserting that the arrows were "sensibly parallel"; the more precise determinations made by Dr. Ludendorff from recent catalogues show us that those arrows are not parallel, but the arrangement is only the more remarkable, for they all diverge with extraordinary accuracy from a single spot at R. A. 123 deg. Dec. 37 deg. N. One might be tempted at first to exclaim that Proctor's whole foundation was obviously rotten if once parallelism is disproved; it was pure luck that led him to associate these five stars, and Fig. 2 must also be unreliable. And yet, as a matter of fact, we have drawn both in Fig. 1 and Fig. 2 from these modern values of the proper motions. The "divergent" happens to be placed precisely on the line that so nearly passes through ζ, ϵ, δ, and β at a distance to the right of β equal to twice the distance from δ to β. We will call the divergent D, and its antipodes, which is therefore the convergent, shall be *C*. It is easy to picture these two points to oneself on the sky if one recalls the appearance of the Great Bear on a September evening lying in the northwest about as shown in Fig. 1. *D* will then be the actual north point of the horizon and *C* will be the exact south point of the horizon (speaking for an observer in latitude 53 deg. N.). Accordingly at such a moment a rod placed horizontally north and south gives us *completely* the direction of the motion of this flock of stars past us. Each arrow on the sky-vault, giving a proper motion, only indicates *partially* the direction of flight, but if we may assume that the convergence means parallelism in perspective, then we know from the convergent the *complete* motion relative to ourselves.

Returning to the actual sky on the September evening at Sid. time 20 hours, i. e., about 8 P. M. on the 21st, suppose we hold a square card with one edge horizontally north and south, and tilt the west side up about 50 deg., we shall find we can draw lines on it which will point quite straight to β, δ, ϵ, and . Ursæ Majoris (γ will be a little below the plane) and we will select β for the moment to represent the group. Let *O N*, Fig. 4, be the edge of the card pointing horizontally north, and *Ou* be directed to β. The angle *NOu* will be 29 deg. Then taking *u* anywhere on this line, *u* can represent the star β and a line *UC* drawn parallel to *NO* represents the direction of β's motion, because it is pointing at *C*, the "convergent" or vanishing point. For the present we know nothing about the magnitude of this motion in miles per second, but let us take a length *uc* to represent this unknown velocity, and we can split it up by the usual methods into *ub* perpendicular to *uO* and *ua* along *uO*.

We must not say that *ub* is the proper motion of the star because proper motion is an angle and *ub* on our diagram is a distance, but they are related by the fact that *ub* equals the angular motion multiplied by *Ou*, the distance of the star.

Now the distance of none of these stars is known, and it is an interesting fact that from the detection of their convergent motion we can deduce their distance, for we shall presently see that we can calculate the value of *ub*, and we know, of course, the angular motion. In the case of β this is 8.7 sec. per century.

Pass now to the components *Ua*, which is the radial or line of sight motion of the star. Dr. Ludendorff has elaborately discussed this question, which is extremely difficult for reasons which we must pass over. For β he obtains the value — 16.8 kilometers, which means an approach of 10½ miles per second. We may therefore say that *ua* = 10½, and since the angle *Cua* = *NOu* = 29 deg. we can deduce that *uc* = 11½, and we have at once the velocity of progress of the whole system; it is 11½ miles per second. Now we can go on to compute *ub*, which must be 11½ cos 61 deg. = 5½—and a little arithmetic will show that if β moves 8.7 seconds per century, and this is really 5½ miles per second, β must be about 400 billion miles away—this would mean a parallax of about 0.05 second, which is by no means unreasonable. It may be of interest to remark that according to Prof. Kapteyn's statistical estimates a star of the magnitude of β with a proper motion comparable to that of β might be expected to have a parallax of 0.025 second. This may be regarded as quite a fair agreement.

So far we have spoken only of β; it will be well to

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* *Knowledge and Scientific News.*

[1] Proc. R. S., vol. xviii, p. 169, and "Other Worlds Than Ours," p. 26.9.

[2] "*Fortnightly Review*," January, 1910.

[3] *Astl Journal*, No. 604.

have it clear what quantities we demand from the other stars if they are accepted as parts of the same flock.

(1) Their proper motions must diverge from *D*— or converge on *C*.

(2) Any known facts about their distance, radial motion, and amount of proper motion must fit in with the assumption that the velocity of the flock is 11½ miles per second. It is extremely unfortunate that for these stars the radial velocities are difficult to ascertain because they appear to be variable. Dr. Ludendorff establishes β as a spectroscopic Binary, and satisfies himself that ϵ is so too, while ζ has long been so recognized. He obtains for ϵ and ζ the radial velocities — 13 and 12.6 kilometers (8.08 and (7.83 miles). If they belong to the flock those quantities should be — 13.2 and — 12.2 (8.20 and 7.38), so this is a fairly strong corroboration, but the main strength of the argument in favor of these five forming a flock is the convergence of their *directions* of proper motion, and their general similarity of magnitude and spectrum and possible duplicity.

We now come to a very pleasing development of this research. Dr. Hertzsprung has sought for other possible members of this flock, not confining his scrutiny to the immediate neighborhood of Ursa Major. The two criteria above mentioned were his guides, the former of the two being naturally first applied. He found six stars whose motion fairly well converged on the point *C*, R. A. 303 deg. Dec. —37 deg., and one would naturally expect that some such result would emerge in reviewing any extensive list of stars. We must not then give much weight to the possible connection unless the second criterion is also satisfied.

Now the only star among the six for which we have the necessary information as to radial velocity and distance is Sirius, and the fact that the evidence is entirely satisfactory will be an exceptionally popular addition to stellar astronomy.

In the first place, the arrow of Sirius's proper motion is directed nearly precisely to the point *C*, and since the length of that arrow is ten times as great as any of Proctor's five stars it affords to that extent a more delicate test. Then the parallax of Sirius is well determined; the Nautical Almanac only recognizes officially three parallaxes—those of Sirius and Centauri, and 61 Cygni, giving that of Sirius the value of 0.37 second. The radial velocity of Sirius has known many vicissitudes, and is at present accepted as —7.4 kilometers; that is to say, *the Sirian system* is approaching us at 4.6 miles per second.

On the September evenings, when *C* and *D* are so conveniently placed on our horizon, Sirius is not far from the Nadir; but without troubling to give the steps of computation it will suffice to state that the second criterion would demand from Sirius the following qualifications:

Parallax should be.....0.387″; it is 0.37″
Radial velocity should be —8.5 ; it is —7.4

This accord justifies us in stating with confidence that Sirius belongs to the same flock as Proctor's five stars, and Mr. Eddington has remarked: "It would have been an interesting theme for the classical mythologists to explain how so important a part of the Great Bear has come to be situated between the teeth of the Great Dog."

There are two further striking inferences to be made from the distances which this discussion discloses. The actual stars of the Great Bear must be from 30 to 130 times as luminous as our sun—which places them, according to Kapteyn's estimates, among the larger of the heavenly bodies, for he only admits about 12 per cent. of the stars to be intrinsically more luminous than the sun. And, secondly, this stream, the existence of which is now accepted, comprises within its limits stars separated from each other by distances up to 30 light-years, say 600 billions of miles.

We pointed out at the beginning of this article that the doctrine of the Fixity of the Stars, immeasurable though its value has been, must now be abandoned, but we may begin to see that its place will be filled by another conception no less stimulating. In the place of the incorruptible crystalline sphere with its fixed stars we have opening gradually before us the appalling picture of the immensity of the universe. The utilitarian who points to navigation and to frontier-staking as the uses of astronomy merely convicts himself of being a shallow philosopher.

Making Money Out of Bees—III*

Keeping Bees for Pleasure and Profit

By E. F. Phillips, Ph.D., in charge of Bee Culture, Bureau of Entomology

Concluded from Supplement No. 1834, page 126

PREPARATION FOR THE HARVEST.

An essential in honey production is to have the hive overflowing with bees at the beginning of the honey flow, so that the field force will be large enough to gather more honey than the bees need for their own use. To accomplish this, the bee keeper must see to it that brood rearing is heavy some time before the harvest, and he must know accurately when the honey flows come, so that he may time his manipulations properly. Brood rearing during the honey flow usually produces bees which consume stores, while brood reared before the flow furnishes the surplus gatherers. The best methods of procedure may be illustrated by giving as an example the conditions in the white-clover region.

In the spring the bees gather pollen and nectar from various early flowers, and often a considerable quantity from fruit bloom and dandelions. During this time brood rearing is stimulated by the new honey, but afterwards there is usually a period of drought when brood rearing is normally diminished or not still more increased as it should be. This condition continues until the white-clover flow comes on, usually with a rush, when brood rearing is again augmented. If such a condition exists, the bee keeper should keep brood rearing at a maximum by stimulative feeding during the drought. When white clover comes in bloom he may even find it desirable to

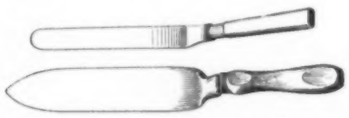

Fig. 18.—Knives for Uncapping Honey

prevent brood rearing to turn the attention of his bees to gathering.

A worker bee emerges from its cell twenty-one days after the egg is laid, and it usually begins field work in from fourteen to seventeen days later. It is evident, therefore, that an egg must be laid five weeks before the honey flow to produce a gatherer. Since the flow continues for some time and since bees often go to the field earlier than fourteen days, egg laying should be pushed up to within two or three weeks of the opening of the honey flow. In addition to stimulative feeding, the care of the colony described under the heading of "Spring managament" will increase brood production.

THE PRODUCTION OF HONEY.

The obtaining of honey from bees is generally the primary object of their culture. Bees gather nectar to make into honey for their own use as food, but generally store more than they need, and this surplus the bee keeper takes away. By managing colonies early in the spring as previously described, the surplus may be considerably increased. The secret of maximum crops is to "Keep all colonies strong."

Honey is gathered in the form of nectar secreted by various flowers, transformed by the bees, and stored in the comb. Bees also often gather a sweet liquid called "honeydew," produced by various scale insects and plant-lice, but the honeydew honey made from it is quite unlike floral honey and should not be sold for honey. It is usually unpalatable and should never be used as winter food for bees. When nectar or honeydew has been thickened by evaporation and otherwise changed, the honey is sealed in the cells with cappings of beeswax.

It is not profitable to cultivate any plant solely for the nectar which it will produce, but various plants, such as clovers, alfalfa, and buckwheat are excellent honey plants

Fig. 19.—Honey Extractor

as well as valuable for other purposes; their cultivation is therefore a benefit to the bee keeper. It is often profitable to sow some plant on waste land; sweet clovers are often used in this way. The majority of honey-producing plants are wild, and the bee keeper must largely accept the locality as he finds it and manage his apiary

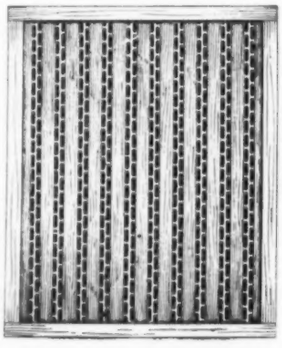

Fig. 20.—Perforated Zinc Queen Excluder

so as to get the largest possible amount of the available nectar. Since bees often fly as far as two or three miles to obtain nectar, it is obvious that the bee keeper can rarely influence the nectar supply appreciably.

EXTRACTED HONEY.

Extracted honey is honey which has been removed by means of centrifugal force from the combs in which the bees stored it. In providing combs for the storage of honey to be extracted, the usual practice is to add to the top of the brood chamber one or more hive bodies just like the one in which brood is reared and fill these with frames. If preferred, shallower frames with bodies of proper size may be used, but most honey extractors are made for full-size frames. The surplus bodies should be put on in plenty of time to prevent the crowding of the brood chamber, and also to act as a preventive of swarming.

Honey for extracting should not be removed until it is well ripened and a large percentage of it capped. It is best, however, to remove the crop from each honey flow before another heavy producing plant comes into bloom, so that the different grades of honey may be kept separate.

The frames containing honey to be extracted are removed from the hive, the cappings cut off with a sharp, warm knife (Fig. 18) made specially for this purpose, and the frames are then put into the baskets of the honey extractor (Fig. 19). By revolving these rapidly the honey is thrown out of one side. The basket is then reversed

Fig. 21.—Shipping Cases for Comb Honey

and the honey from the other side is removed. The combs can then be returned to the bees to be refilled, or if the honey flow is over, they can be returned to the bees to be cleaned and then removed and stored until needed again. This method is much to be preferred to mashing the comb and straining out the honey, as was formerly done.

The extracted honey is then strained and run into vessels. It is advisable not to put it in bottles at once, but to let it settle in open vessels for a time, so that it can be skimmed. Most honeys will granulate and become quite hard if exposed to changes of temperature, and to liquefy granulated extracted honey it should be heated in a water bath. Never heat honey directly over a stove or flame, as the flavor is thereby injured. The honey should never be heated higher than 160 deg. F., unless it is necessary to sterilize it because of contamination of disease.

Extracted honey is put up in bottles or small tin cans for the retail trade, and in 5-gallon square tin cans or barrels for the wholesale market. Great care must be exercised if barrels are used, as honey will absorb moisture from the wood, if any is present, and cause leakage. The tin package is much to be preferred in most cases. In bottling honey for retail trade, it will well repay the bee keeper or bottler to go to considerable expense and trouble to make an attractive package, as the increased price obtained will more than make it up. Honey should be heated to 160 deg. F., and kept there for a time before

*Farmers Bulletin No. 397, U. S. Department of Agriculture.

bottling, and the bottle should be packed as full as possible and sealed hermetically.*

COMB HONEY.

Comb honey is honey as stored in the comb by the bees, the size and shape being determined by the small wooden sections provided by the bee keeper. Instead of having comb in large frames in which to store surplus honey, the bees are compelled to build comb in the sections and to store honey there (Fig. 2). A full section weighs about 1 pound; larger ones are rarely used. By the use of modern sections and foundation the comb honey now produced is a truly beautiful, very uniform product—so uniform in fact that it is often charged that it must be artificially manufactured. The purchaser of a section of comb honey may be absolutely certain, however, that he is obtaining a product of the bees, for never has anyone been able to imitate their work successfully. To show their confidence in the purity of comb honey, the National Bee Keepers' Association offers $1,000 for a single pound of artificial comb filled with an artifically prepared sirup.

There are several different styles of sections now in use, the usual sizes being 4¼ inches square and 4 inches by 5 inches. There are also two methods of spacing, so that there will be room for the passage of bees from the brood chamber into the sections and from one super of sections to another. This is done either by cutting "bee ways" in the sides of the sections and using plain flat separators or by using "no bee-way" or plain sections and using "fences"—separators with cleats fastened on each side, to provide the bee space. To describe all the different "supers" or bodies for holding sections would be impossible in a bulletin of this size, and the reader must be referred to catalogues of dealers in bee-keeping supplies. Instead of using regular comb-honey supers, some bee keepers use wide frames to hold two tiers of sections. It is better, however, to have the supers smaller, so that the bees may be crowded more to produce full sections. To overcome this difficulty, shallow wide frames holding one tier of sections may be used. The majority of bee keepers find it advisable to use special comb-honey supers.

In producing comb honey it is even more necessary to know the plants which produce surplus honey and just when they come in bloom than it is in extracted honey production. The colony should be so manipulated that the maximum field force is ready for the beginning of the flow. This requires care in spring management, and above all the prevention of swarming. Supers should be put on just before the heavy flow begins. A good indication of the need of supers is the whitening of the brood combs at the top. If the bees are in two-hive bodies they should generally be reduced to one, and the frames should be filled with brood and honey so that as the new crop comes in the bees will carry it immediately to the sections. If large hives are used for the brood chamber it is often advisable to remove some of the frames and use a division board to crowd the bees above. To prevent the queen from going into the sections to lay, a sheet of perforated zinc (Fig. 20) may be put between the brood chamber and the super (Fig. 2).

It is often difficult to get bees to begin work in the small sections, but this should be brought about as soon as possible to prevent loss of honey. If there are at hand some sections which have been partly drawn the previous year, these may be put in the super with the new sections as "bait." Another good plan is to put a shallow extracting frame on either side of the sections. If a few colonies in the apiary that are strong enough to go above still refuse, lift supers from some colonies that have started to work above and give them to the slow colonies. The super should generally be shaded somewhat to keep it from getting too hot. Artificial swarming will quickly force bees into the supers.

To produce the finest quality of comb honey full sheets of foundation should be used in the sections. Some bee keepers use nearly a full sheet hung from the top of the section and a narrow bottom starter. The use of foundation of worker-cell size is much preferred.

When one super becomes half full or more and there are indications that there will be honey enough to fill others, the first one should be raised and an empty one put on the hive under it. This tiering up can be continued as long as necessary, but it is advisable to remove filled sections as soon as possible after they are nicely capped, for they soon become discolored and less attractive. Honey removed immediately after capping finds a better market, but if left on the hive even until the end of the summer the quality of the honey is improved. A careful watch must be kept on the honey flow, so as to give the bees only enough sections to store the crop. If this is not done a lot of unfinished sections will be left at the end of the flow. Honeys from different sources should never be mixed in the sections, as it gives the comb a bad appearance.

To remove bees from sections, the super may be put over a bee escape so that the bees can pass down but can not return, or the supers may be removed and covered with a wire-cloth-cone bee escape.

After sections are removed the wood should be scraped free of propolis (bee glue) and then packed in shipping cases (Fig. 21) for the market. Shipping cases to hold 12, 24 or 48 sections, in which the various styles of sections fit exactly, are manufactured by dealers in supplies. In shipping these cases, several of them should be put in a box or crate packed in straw and paper and handles provided to reduce the chances of breakage. When loaded in a freight car the combs should be parallel with the length of the car.

In preparing comb honey for market it should be carefully graded, so that the sections in each shipping case are as uniform as possible. Nothing will more likely cause wholesale purchasers to cut the price than to find the first row of sections in a case fancy and those behind of inferior grade. Grading rules have been adopted by various bee keepers' associations or drawn up by honey dealers. The following set of rules are in general use:

Eastern Grading Rules for Comb Honey.

Fancy.—All sections well filled; combs straight; firmly attached to all four sides; the combs unsoiled by travel, stain, or otherwise; all the cells sealed except an occasional one; the outside surface of the wood well scraped of propolis.

A No. 1.—All sections well filled except the row of cells next to the wood; combs straight; one-eighth part of comb surface soiled, or the entire surface slightly soiled; the outside surface of the wood well scraped of propolis.

No. 1.—All sections well filled except the row of cells next to the wood; combs comparatively even; one-eighth part of comb surface soiled, or the entire surface slightly soiled.

No. 2.—Three-fourths of the total surface must be filled and sealed.

No. 3.—Must weigh at least half as much as a full-weight section.

In addition to this the honey is to be classified according to color, using the terms white, amber, and dark; that is, there will be "Fancy White," "No. 1 Dark," etc. New Comb-Honey Grading Rules Adopted by the Colorado State Bee Keepers' Association.

No. 1 *White.*—Sections to be well filled and evenly capped, except the outside row, next to the wood; honey white or slightly amber, comb and cappings white, and not projecting beyond the wood; wood to be well cleaned; cases of separatored honey to average 21 pounds net per case of 24 sections; no section in this grade to weigh less than 13½ ounces. Cases of half-separatored honey to average not less than 22 pounds net per case of 24 sections. Cases of unseparatored honey to average not less than 23 pounds net per case of 24 sections.

No. 2 *Light Amber.*—Sections to be well filled and evenly capped, except the outside row, next to the wood; honey white or light amber; comb and cappings from white to off color, but not dark; comb not projecting beyond the wood; wood to be well cleaned. Cases of

A PENNSYLVANIA APIARY.

REMOVING A BEE THAT HAS STUNG THE BEE-KEEPER.

A BEE COLONY ON THE ROOF OF A HOUSE.

A QUICK DOWNWARD JERK PRECIPITATES THE BEES ON THE ROOF.

*For further discussion of the production and care of extracted honey, see Bulletin 75, Part 1, Bureau of Entomology. It may be obtained from the Superintendent of Documents, Washington, D. C. Price 5c.

separatored honey to average 21 pounds net per case of 24 sections; no section in this grade to weigh less than 13½ ounces. Cases of half-separatored honey to average not less than 22 pounds net per case of 24 sections. Cases of unseparatored honey to average not less than 23 pounds net per case of 24 sections.

No. 3.—This includes all white honey, and amber honey not included in the above grades; sections to be fairly well filled and capped, no more than 25 uncapped cells, exclusive of outside row, permitted in this grade; wood to be well cleaned; no section in this grade to weigh less than 12 ounces. Cases of separatored honey to average not less than 19 pounds net. Cases of half-separatored honey to average not less than 20 pounds net per case of 24 sections. Cases of unseparatored honey to average not less than 21 pounds net per case of 24 sections.

THE PRODUCTION OF WAX.

Beeswax, which is secreted by the bees and used by them for building their combs, is an important commercial product. There are times in almost every apiary when there are combs to be melted up, and it pays to take care of even scraps of comb and the cappings taken off in extracting. A common method of taking out the wax is to melt the combs in a solar wax extractor. This is perhaps the most feasible method where little wax is produced, but considerable wax still remains in old brood combs after such heating. Various wax presses are on the market, or one can be made at home. If much wax is produced, the bee keeper should make a careful study of the methods of wax extraction, as there is usually much wax wasted even after pressing.

PREPARATIONS FOR WINTERING.

After the main honey flow is over the management must depend on what may be expected later in the season from minor honey flows. If no crop is to be expected, the colony may well be kept only moderately strong, so that there will not be so many consumers in the hive.

In localities where winters are severe and breeding is suspended for several months great care should be taken that brood-rearing is rather active during the late summer, so that the colony may go into winter with plenty of young bees. In case any queens show lack of vitality they should be replaced early, so that the bees will not become queenless during the winter.

The important considerations in wintering are plenty of young bees, a good queen, plenty of stores of good quality, sound hives, and proper protection from cold and dampness.

If, as cold weather approaches, the bees do not have stores enough, they must be fed. Every colony should have from 25 to 50 pounds, depending on the length of winter and the methods of wintering. It is better to have too much honey than not enough, for what is left is good next season. If feeding is practiced, honey may be used, but sirup made of granulated sugar is just as good and is perfectly safe. If honey is purchased for feeding, great care should be taken that it comes from a healthy apiary, otherwise the apiary may be ruined by disease. *Never feed honey bought on the open market.* The bees should be provided with stores early enough so that it will not be necessary to feed or to open the colonies after cold weather comes on. Honeydew honey should not be left in the hives, as it produces "dysentery." Some honeys are also not ideal for winter stores. Those which show a high percentage of gums (most tree honeys) are not so desirable, but will usually cause no trouble.

In wintering out of doors the amount of protection depends on the severity of the winter. In the South no packing is necessary, and even in very cold climates good colonies with plenty of stores can often pass the winter with little protection, but packing and protection make it necessary for the bees to generate less heat, and consequently they consume less stores and their vitality is not reduced. Dampness is probably harder for bees to withstand than cold, and when it is considered that bees give off considerable moisture, precautions should be taken that as it condenses it does not get on the cluster. An opening at the top would allow the moisture to pass out, but it would also waste heat, so it is better to put a mat of burlap or other absorbent material on top of the frames. The hive may also be packed in chaff, leaves, or other similar dry material to keep out the cold. Some hives are made with double walls, the space being filled with chaff; these are good for outdoor wintering. The hive entrance should be lower than any other part of the hive, so that any condensed moisture may run out. The hives should be sound and the covers tight and waterproof.

Entrances should be contracted in cold weather not only to keep out cold wind, but to prevent mice from entering. There should always be enough room, however, for bees to pass in and out if warmer weather permits a flight.

In the hands of experienced bee keepers cellar wintering is very successful, but this method requires careful study. The cellar must be dry and so protected that the temperature never varies more than from 40 to 45 deg. F.; 43 deg. F. seems to be the optimum temperature. The ventilation must be good or the bees become fretful. Light should not be admitted to the cellar, and consequently some means of indirect ventilation is necessary.

Cellar wintering requires the consumption of less honey to maintain the proper temperature in the cluster and is therefore economical. Bees so wintered do not have an opportunity for a cleansing flight, often for several months, but the low consumption makes this less necessary. Some bee keepers advocate carrying the colonies out a few times on warm days, but it is not fully established whether this is entirely beneficial and is usually not practiced.

The time for putting colonies in the cellar is a point of dispute, and practice in this regard varies considerably. They should certainly be put in before the weather becomes severe and as soon as they have ceased brood rearing. The time chosen may be at night when they are all in the hive, or on some chilly day.

The hives may be piled one on top of the other, the lower tier raised a little from the floor. The entrances should not be contracted unless the colony is comparatively weak. It is usually not considered good policy to close the entrances with wire cloth, as the dead bees which accumulate more or less on the bottom board may cut off ventilation, and the entrance should be free so that these may be cleaned out.

The time of removing bees from the cellar is less easily determined than that of putting them in. The colonies may be removed early and wraped in *black* tar paper or left until the weather is settled. If the weather is very warm and the bees become fretful, the cellar must either be cooled or the bees removed. Some bee keepers prefer to remove bees at night, so that they can recover from the excitement and fly from the hive normally in the morning. One of the chief difficulties is to prevent the bees from getting into the wrong hives after their first flights. They often "drift" badly with the wind, and sometimes an outside row will become abnormally strong, leaving other colonies weak.

DISEASES AND ENEMIES.

There are two infectious diseases of the brood of bees which cause great losses to the bee-keeping industry of the United States. These are known as American foul brood and European foul brood. Both of these diseases destroy colonies by killing the brood, so that there are not enough young bees emerging to take the place of the old adult bees as these die from natural causes. The adult bees are not attacked by either disease. In the hands of careful bee keepers both diseases may be controlled, and this requires careful study and constant watching. In view of the fact that these diseases are now widely distributed throughout the United States, every bee keeper should read the available literature on the subject, so that if disease enters his apiary he may be able to recognize it before it gets a start. The symptoms and the treatment recommended by this Department are given in another publication which will be sent free on request.*

It is difficult for a bee keeper to keep his apiary free from disease if others about him have diseased colonies which are not properly treated. The only way to keep disease under control is for the bee keepers in the neighborhood to cooperate in doing everything possible to stamp out disease as soon as it appears in a single colony. The progressive bee keeper who learns of disease in his neighborhood should see to it that the other bee keepers around him are supplied with literature describing symptoms and treatment, and should also try to induce them to unite in eradicating the malady. Since it is so often impossible to get all the bee keepers in a community to treat infected colonies properly and promptly, it is desirable that the States pass laws providing for the inspection of apiaries and granting to the inspector the power to compel negligent bee keepers to treat diseased colonies so that the property of others may not be endangered and destroyed. This has been done in a number of States, but there are still some where the need is great and in which no such provision has been made. When no inspection is provided, bee keepers should unite in asking for such protection, so that the danger to the industry may be lessened.

In case there is an inspector for the State or county, he should be notified as soon as disease is suspected in the neighborhood. Some bee keepers hesitate to report disease through fear that the inspector will destroy their bees or because they feel that it is a disgrace to have disease in the apiary. There is no disgrace in having colonies become diseased; the discredit is in not treating them promptly. The inspectors are usually, if not universally, good practical bee keepers who from a wide experience are able to tell what should be done in individual cases to give the best results with the least cost in material and labor. They do not destroy colonies needlessly, and, in fact, they all advocate and teach treatment.

The brood diseases are frequently introduced into a locality by the shipping in of diseased colonies; or, more often, the bees get honey from infected colonies which is fed to them, or which they rob, from discarded honey cans. It is decidedly dangerous to purchase honey on the market, with no knowledge of its source, to be used in feeding bees. Many outbreaks of disease can be traced to this practice. It is difficult to prevent bees from getting contaminated honey accidentally. If colonies are purchased, great care should be taken that there is no disease present. Whenever possible, colonies should be purchased near at home, unless disease is already present in the neighborhood.

There are other diseased conditions of the brood, known to bee keepers as pickled brood, but these can usually be distinguished from the two diseases previously mentioned. The so-called "pickled brood" is not contagious and no treatment is necessary. Bees also suffer from "dysentery," which is discussed in the earlier part of this bulletin, and from the so-called "paralysis," a disease of adult bees. No treatment for the latter disease can as yet be recommended as reliable. The sprinkling of powdered sulphur on the top bars of frames or at the entrance is sometimes claimed to be effective, but under what circumstances it is beneficial is unknown.

A number of insects, birds, and mammals must be classed as enemies of bees, but of these the two wax moths, and ants, are the only ones of importance. There are two species of moth, the larger wax moth (*Galleria mellonella* L.) and the lesser wax moth (*Achroia grisella* Fab.), the larvæ of which destroy combs by burrowing through them.* Reports are frequently received in the Department that the larvæ of these moths (usually the larger species) are destroying colonies of bees. It may be stated positively that moths do not destroy strong healthy colonies in good hives, and if it is supposed that they are causing damage the bee keeper should carefully study his colonies to see what other trouble has weakened them enough for the moths to enter. Queenlessness, lack of stores, or some such trouble may be the condition favorable to the entrance of the pest, but a careful examination should be made of the brood to see whether there is any evidence of disease. This is the most frequent cause of the cases of moth depredation reported to this Department. Black bees are less capable of driving moth larvæ out, but, even with these bees, strong colonies rarely allow them to remain. The observance of the golden rule of bee keeping, "Keep all colonies strong," will solve the moth question unless disease appears.

Moth larvæ often destroy combs stored outside the hive. To prevent this the combs may be fumigated with sulphur fumes or bisulphid of carbon in tiers of hives or in tight rooms. If bisulphid of carbon is used, great care should be taken not to bring it near a flame, as it is highly inflammable. Combs should be stored in a dry, well-ventilated, light room.

In the warmer parts of the country ants are often a serious pest. They may enter the hive for protection against changes of temperature, or to prey on the honey stores or the brood. The usual method of keeping them out is to put the hive on a stand, the legs of which rest in vessels containing water or creosote. Another method is to wrap a tape soaked in corrosive sublimate around the bottom board.

GENERAL INFORMATION.

For the purpose of answering numerous questions which are asked of this Department the following brief topics are included.

BREEDERS OF QUEENS.

There are a large number of bee keepers who make a business of rearing queens of good stock for sale. The queens are usually sent by mail. If poor stock is all that can be obtained locally, it is recommended that such colonies be purchased and the queens removed and replaced with those obtained from a good breeder. This Department can supply names of breeders, nearest the applicant, of any race raised in this country.

INTRODUCING QUEENS.

When queens are shipped by mail they usually come in cages which can be used for introducing. If the colony to receive the new queen has one, she must be removed and the cage inserted between the frames. The small hole leading into the candy compartment is uncovered, and the bees gradually eat through and release the queen. If queens are reared at home, a similar cage may be used for introducing.

In view of the fact that disease may be transmitted in mailing cages, it is always a wise precaution to remove the new queen and destroy the accompanying workers and the cage and its contents. The queen may then be put into a clean cage without worker bees with candy known to be free from contamination (made from honey from healthy hives) and introduced in the regular way. Queens sold by breeders are always mated unless otherwise specified, and consequently the colony in which they are introduced has no effect on the offspring. During the active season the bees in the colony are all the offspring of the new queen in about nine weeks. Three weeks is required for the previous brood to emerge (if the colony has not been queenless), and in six weeks after all the old brood emerges most of the workers from it will have died.

DEALERS IN BEE KEEPERS' SUPPLIES.

There are several manufacturers of supplies in this country who can furnish almost anything desired by the bee keeper. Some of them have agents in various parts of the country from whom supplies may be purchased, thus saving considerable in freight.

BEE KEEPERS' ASSOCIATIONS.

There are a large number of associations of bee keepers in all parts of the country, formed for the betterment of the industry and a few associations which are organized to aid the members in purchasing supplies and in selling the crops. Of these the National Beekeepers' Association is the largest. It helps its members in obtaining their legal rights, and aids in securing legislation for the furtherance of the industry. The annual conventions are held in different parts of the country, and copies of the proceedings are sent to the members. There are also numerous state, county, and town associations, some of which publish proceedings. The names of officers of the nearest associations or of the National Beekeepers' Association will be sent on request from this Department.

LAW AFFECTING BEE KEEPING.

Disease inspection.—Various States have passed laws providing for the state or county inspection of apiaries for bee-disease control, and every bee keeper should get in touch with an inspector when disease is suspected, if one is provided. The inspectors are practical bee keepers who fully understand how to control the diseases, and are of great help in giving directions in this matter. The name of the inspector of any locality can usually be furnished, and this department is glad to aid bee keepers in reaching the proper officers.

Laws against spraying fruit trees while in bloom.—The spraying of fruit trees while in bloom is not now advised by economic entomologists, and to prevent the practice

*Circular 79, Bureau of Entomology, U. S. Department of Agriculture. The Brood Diseases of Bees.

*Bee keepers refer to these insects as "moths," "wax moths," "bee moths," "millers," "wax worms," "honey moths," "moth worms," "moth millers" and "grubs." The last six terms are not correct.

some States have passed laws making it a misdemeanor. Such spraying not only kills off honeybees, causing a loss to the bee keeper, but interferes with the proper pollination of the blossoms and is thus a detriment to the fruit grower. Bee keepers should do everything in their power to prevent the practice.

Laws against the adulteration of honey.—The National Food and Drugs Act of 1906, and various state pure food laws, are a great aid to the bee keeper in preventing the sale of adulterated extracted honey as pure honey. Bee keepers can often aid in this work by reporting to the proper officials infringements of these laws which come to their notice.

When bees are a nuisance.—Some cities have passed ordinances prohibiting the keeping of bees in certain areas, but so far none have been able to enforce them. If bees are a nuisance in individual cases, the owner may be compelled to remove them. The National Beekeepers' Association will help any of its members in such cases, if they are in the right, as well as in cases where bees sting horses. Bee keepers should be careful not to locate bees where they can cause any trouble of this kind.

SUPPOSED INJURY OF CROPS BY BEES.

Bee keepers are often compelled to combat the idea that bees cause damage to fruit or other crops by sucking the nectar from the flower. This is not only untrue, but in many cases the bees are a great benefit in pollinating the flowers, making a good crop possible. A more frequent complaint is that bees puncture fruit and suck the juices. Bees never puncture sound fruit, but if the skin is broken by some other means bees will often suck the fruit dry. In doing it, however, they are sucking fruit which is already damaged. These and similar charges against the honeybee are prompted by a lack of information concerning their activities. Bees may, of course, become a nuisance to others through their stinging propensities, but bee keepers should not be criticised for things which bees do not do.

Some Mental Illusions of Vision

Explanations of Various Optical Phenomena

By R. T. Lewis, F.R.M.S.

NOTWITHSTANDING the popular saying that "seeing is believing," neither of our faculties is subject to such complete illusions as our sense of sight, some being optical, others ocular, while again others are purely mental.

To the first kind belong those due to refraction—such for instance as the mirage, or the apparent displacement of an object from its true position; to the second kind may be referred the phenomena of irradiation, and of subjective images and colors; while the third includes the impression which most persons have of the apparent increase of the size of the Sun and Moon when rising or setting, and the similar increase in the apparent size of constellations, or the distance apart of stars when seen near the horizon, as compared with our estimate of such at their meridian altitude.

That this last-named illusion is neither optical nor ocular is shown at once by the fact that when seen through a telescope no such apparent increase is found to exist; indeed, when accurately measured, after making all necessary corrections for height of barometer, temperature, and refraction in altitude, it is found that the apparent diameter of either body is really greatest when on the meridian, inasmuch as they are then some 4,000 miles nearer to us than when near the horizon, though the difference is too small to be appreciated by the naked eye.

It should be noted, however, that the amount of the apparent augmentation varies considerably with individuals; artists, for instance, depict the rising moon of a variety of exaggerated sizes up to about 15 deg. diameter, or about thirty times greater than it should be drawn, and one not infrequently hears it described as looking "as large as a dinner plate," whereas a three-penny bit held at arm's length is rather larger than is necessary to hide it completely.

That this almost universal illusion is entirely mental, is not easy to demonstrate, although it will be readily admitted that if a false impression of the distance of an object can be created, the mental estimate of its actual size will be proportionately altered; in other words, if an object we believe to be near to us appears of a certain size, and one of the same kind believed to be at a distance appears also of the same size, we at once from experience correctly judge that the latter must be the larger of the two. Hence though the Moon, whether high or low in the sky, practically subtends the same angle, and therefore its image on the retina of the eye is in both positions the same, we naturally from experience imagine it must be a larger body in the latter case, because though so much farther off it appears to be of the same size as the Moon we see when apparently nearer.

The experiment referred to in the accompanying diagram affords a convincing illustration of the curious mental effect produced by the creation of a false impression of distance, and is one which may be performed by any persons who possess sufficient control of the eyes to dissociate the focusing and the convergence, which though quite separate and independent actions, are from constant habit usually performed automatically together. *A-B* represents a stereoscopic slide, which we will suppose to be of the full Moon, placed at the normal distance of ten inches from the eyes, when the two pictures are seen clearly in focus. If while retaining the focal distance we alter the convergence so that the axis of the right eye (*R*) passes centrally through the picture *B*, and that of the left eye (*L*) through the center of *A*, as shown by the two firm lines *L-C* and *R-C*, these axes will meet at the point *C*, which will be more or less distant from the plane of *A-B* according to the width apart of the eyes of the observer. The result of this will be that three images of the pictures *A* and *B* will be seen, of which the central one, consisting of *A* and *B* superposed, will be seen apparently at *C*, and of course perfectly stereoscopic. If then without altering the distance between the eyes and the slide we look so "cross eyed" that the axis of *R* passes centrally through *A*, and that of *L* through *B*, as indicated by the two dotted lines, we shall again see three images, the center one apparently at *D*, but in this case pseudoscopic. It is clear that in both cases the images of the pictures on the sympathetic portions of the retina will be approximately the same, but in the former case where the Moon is seen apparently at *C*, or much farther off than it really is, the effect is that of a considerably magnified image, whereas in the latter case where the picture is seen apparently at *D*, or much nearer than it really is, the mental impression produced (after making due allowance for the difference between *R-A* and *R-B*) is that of a considerably smaller Moon than either of those seen at *A-B*, the mental illusion in each case being due to the fact that a false idea has been created as to the distances of the objects observed.

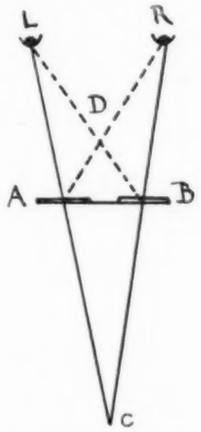

Diagram Illustrating False Impressions of Distance

A further experiment may be suggested by means of the subjective image of any object which is gazed upon long enough to produce a continued impression upon the eyes. If, for instance, the filament of an incandescent electric lamp is steadily looked at for a few seconds, the impression produced by it upon the sympathetic portions of the eyes will persist until the vibrations so excited have run down, and a spectral image of the filament will meanwhile be seen so long as the convergence of the eyes is maintained at the same angle as when the lamp was originally looked at. If this image is projected upon the distant wall of the room it will appear of magnified proportions, whereas if thrown upon some surface nearer to the eye than the exciting cause, it will apparently be seen of very reduced dimensions, although in both cases the actual picture formed must be precisely the same.

As yet another, though somewhat different class of mental illusion in the case of vision, I may mention that I have before me a photograph of the "Challenger" medal, taken under a strong oblique light, falling upon it from the top. Knowing from experience that if the light falls in that direction upon a raised surface, the shadows would fall as depicted, the mental impression produced when the top of the photograph is held toward a source of light is that of a design in strong relief, although the sense of touch assures me it is flat; but if the picture is turned round so that the light falls upon it from the bottom, experience immediately suggests that shadows, as they then appear, can only be thrown by an intaglio, and the mental suggestion is that of a sunk pattern, an illusion which would be complete but for the fact that the inscription still reads the right way about.

A false estimate of distance, and therefore of size, is very common to persons in the clear air of high mountainous regions, who under ordinary circumstances are accustomed to see landscapes through our own more murky atmosphere, and the common illusion of meeting suddenly with gigantic figures in the street on a foggy night, because they are much closer than imagined, will occur to most people.

It seems also quite within the limits of possibility that some of the errors of interpretation as to the meaning of what is seen under the microscope may be due to mental suggestion.

It will be understood that the extent of such illusions as have been referred to varies somewhat according to the "personal equation" of the observer, and that what has been described is simply the experience of the writer, who it may be of some interest to mention, has since he thought out the matter, almost entirely lost the impression that the Sun and the Moon appear larger when rising or setting than at other times, though he has been quite unable to divest himself from the illusion in the case of constellations or stars.—*Knowledge.*

Moving Picture Camera, as a Hand Camera, by Using a Gyroscope

AT a recent meeting of the Societe de Physique, of Paris, an interesting method of taking moving picture views was presented by M. De Proszynski. Heretofore such a camera had to be mounted on a tripod to keep it quite steady and it was generally turned by a hand crank. The inventor succeeds in making a hand camera for use in taking such views. He keeps it steady by using the principle of the gyroscope in an ingenious way, so that holding it in the hand causes no trembling. But the problem was how to drive the gyroscope and also the film machine, as an electric motor with a battery is not practical, neither is a spring motor. He uses a small compressed air motor devised for the purpose, and it is very compact. It gives no shocks when running, which is, of course, an essential point. A unique feature is that an ordinary bicycle pump is used to fill the air cylinder of the motor, so that the whole can be made in the form of a hand camera about the size of a large kodak, and it is thus self-contained. The inventor showed what the camera would do by projecting some street views on a screen. These were taken when moving the camera about in the hand quite rapidly, and the images were remarkably sharp. We expect to illustrate this apparatus in the near future.

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Meat cutter, J. J. Heckman 984,668
Metal shearing machine, rotary, D. Lennox 984,575
Metallurgical purposes, container for, M. F. Willfong 984,986
Milk can, W. F. Donnell 984,921, 985,016
Mine, submarine, Hunt & Walker 984,674
Mixing or tumbling machine, S. J. Morgan 984,694
Moccasin, G. H. Bass 984,739
Molder's tool, J. Whitehead 984,985
Molding cleaner, Wilson & Green 984,988
Motor control system, electric, Eastwood & Schnabel 984,651
Mower, lawn, H. L. Leonard 984,941
Mule, self-acting, P. Vindrier 984,786
Music sheets, machine for making perforated, P. J. Meahl 984,834
Neckties, cord for, W. E. Davies 984,751
Net, landing, E. A. Covell 985,114
Nitrogen and carbon dioxid from gaseous products of combustion, producing, Reichel & Braun 984,605
Nozzle, high pressure, H. H. Gorter 984,557
Numbering machine, W. H. Smith, reissue 13,212
Nut lock, A. M. Ponkey 985,059
Oil can, E. B. Rose 985,066
Ore concentrating and placer machine, aero, E. H. Tate 984,866
Ore concentrators, table adjustment for, H. F. Furs 984,567
Ores, process of and apparatus for concentrating metalliferous, H. E. Wood 984,633
Ornamenting device, Winterbottom & Bennett 984,632
Outlet box, N. Marshall 984,771
Overshoe, calk bearing, G. S. Meyer 984,957
Oxidizing nitrogen of air by means of electric discharges, K. Kaiser 984,925
Ozone, composition yielding, A. H. Twomby 984,722
Packing, S. P. & V. Morrison 984,836
Packing expander, piston, G. Christenson. 984,888
Pail attachment, milk, C. T. Herbold, Jr. 985,030
Pail, dinner, W. A. Edwards 985,020
Paper roll holder and cutter, R. P. Hendrickson 984,910
Paper or marking apparatus, W. K. Trotman 984,618
Paring machine, F. B. Pease 984,843
Pavements, making, C. Davis 984,891
Paving, curbing, and forming, D. Crockett 984,543
Pedal, auxiliary, J. R. Tyson 984,723
Pen, fountain, J. H. Shunk, Jr 984,710
Pencil calendar and clip, M. R. Moffitt .. 985,051
Photographic films, manufacture of, K. Brandenberger 984,886
Piano actions, etc., valve for pneumatic, A. J. Hobart 985,033
Piano playing attachments, folding treadle for, R. J. Bennett 984,527, 984,528
Pianos, etc., playing apparatus for, J. F. Kelly 984,677
Picker strap, N. Lemaire 984,821
Pin. See Belt pin.
Pins, device for bending ends of, L. Baum. 985,103
Pipe bends, making U-shaped, P. Esch 984,652
Pipe fastener, L. Zachara 985,094
Pipe threading machine, Stoops & Larick. 984,615
Pipes, noise muffler for exhaust, D. W. Dudderar 984,890
Piston and cylinder construction, Morrison & Bruce 984,837
Piston head, F. P. Boesch 985,005
Plane, dado, H. Smiley 984,610
Planter attachment, A. J. Anderson 984,731
Planting machine, Woodruff & Lawson 984,626
Plastic material, machine for pressing, A. B. Klay 984,933
Plate holder, magazine, R. Goldstein 984,901
Plows, self-side draft device for, W. W. McCall 984,581
Plume, F. T. Schrauck 984,973
Plunge bath, rotary, V. V. Messer 984,956
Pneumatic despatch system carrier, C. S. Jennings 984,816
Power transmitting apparatus, hydraulic, C. R. Radcliffe 984,849
Power transmitting mechanism, J. F. Barfoth 984,526
Precious metals, apparatus for obtaining, J. R. Parks 984,842
Printer's tie-up, H. R. Smith 984,976
Printing machine, F. Davis 984,545
Printing machinery, ink or color mechanism for, J. A. J. Hayes 984,913
Printing mechanism for adding machines, J. C. Cunningham 985,042
Printing press, hand, J. W. Read 984,968
Printing presses, building up forms in, F. J. Sinder 984,859
Projecting apparatus, J. Schneider 985,088
Projection apparatus, relaying, G. A. H. Kellner 984,929
Proteid composition, obtaining soluble and coagulable, L. L. Chavassieu 984,539
Pull switch, G. W. Goodridge 984,902
Pulp beating engine, F. J. Marshall 984,830
Pulverizer roller, Worst & Kilmer 984,989
Pump, M. McCarty 984,833
Pump, air, Raymond 985,013
Pump, double plunger, J. C. Whitmer 984,872
Pump, oil, Hansen & Grohmann 984,811
Pump, oil well, M. J. Morton 984,962
Pump rod guide, J. Johnson 984,764
Punch, gang, W. O. Besaw 984,530
Push button, C. Auth 985,101
Rack. See Clothes rack.
Rail joint, J. Diehl-Werman 984,546
Rail joint, W. Jurgens 984,924
Rail joint, G. B. Anderson 985,096
Rail joint, insulated, B. Wolhaupter 984,982
Railway gate, J. Flynn 984,980
Railway tie, J. A. Brooks 984,535
Railway track safety device, Carlton & Ryle 985,006
Rands and other fabrics, water repellent and coloring the same, A. M. Hart 984,665
Razor, safety, H. G. Cook 984,800
Razor, safety, R. T. Winn 985,089
Receptacle, R. J. Bradshaw 985,106
Reel holder, J. F. Weaver 984,627
Refrigerator, W. M. Strothers 984,714
Refrigerator, U. S. Meeks 984,835
Refrigerator lining, W. H. Whittier 984,873
Reloading tool, C. D. Reed 984,852
Ribbon bows and the like, fastening device for, G. E. Tarnow 985,075
Rim, demountable, P. J. McCullough 984,833
Ring mold, J. Pfeiffer 984,959
Rolling mill for metal tubes, M. Koch 984,569
Roofing paper waterproof lock seam for, F. E. Smith 984,800
Rotary engine, A. E. Greene 984,904
Rotary engine, J. H. Watson 984,983
Rotary engine, K. & E. Wittig 985,091
Routing machine, G. Schrade 985,117
Row lock, G. Gable 985,049
Rubber or similar material to an impalpable powder, machine for reducing, C. E. Gardner 984,738
Rubber sole, R. E. Foster 984,901
Saddle, D. D. Lowe 984,576
Safe, milk bottle, Cooper & Prismall 984,542
Salts, process and apparatus for the electrolytic decomposition of alkaline, J. Greenwood 984,905
Sand blast apparatus, C. W. Ebeling 984,753
Sash fastening device, W. F. O'Rourke 984,594
Saw handle, crosscut, L. Shallcross 984,975
Scale, P. Munn 984,961
Scoop, Miller & Bingaman 984,774
Scraper and drag, combined, H. S. Wood. 984,634
Screen. See House screen.
Screw, H. G. Reiniger 984,969
Screw driver, Kluckhuhn & Scott 984,932
Screw driver, spiral eye, C. M. Wilson 985,087
Seat, W. J. Baker 984,736
Seat car, W. K. Edgar 985,019
Sectional sheet, C. P. Tilton 984,784
Seed tester, J. H. Brown 984,746
Separatory apparatus, Jacobson & Dinsmore 984,923
Sewing machine or attachment for same, A. E. Holmberg 984,562
Sewing machine presser bar clamping device, C. McNeil 984,690
Sewing machine trimming attachment, W. Kohn 985,115
Sharpening apparatus, blade, R. T. Winn. 985,088
Sharpening machines, feed finger for saw, J. P. Hedstrom 984,669
Shears and scissors, E. Meissner 985,048
Sheet conveying machines, slow-down mechanism for, T. C. Dexter 985,014
Sheet holder, sample, J. P. Tirrill 984,867
Sheet metal box, slip cover, F. Eberhart .. 984,548
Shelf attachment, tent, W. C. Brown 985,002
Shelf frame with vertically adjustable shelves, R. Schuftan 984,857
Shelving, sectional, A. A. Oestreicher 984,593
Shingle cutting machine, C. Warwick 984,624
Shingle drying machine, C. Warwick 984,623
Ships at sea, apparatus for coaling, J. H. Michener, Jr 984,692
Shocking tool, C. M. Green 984,761
Shoe cleaning device, P. E. Aronis 984,949
Shoe form, W. S. Lungee 984,770
Shovels, spades, and similar articles, rolls for the manufacture of, J. Atkins 984,790
Shovels, spades, etc., rolls for the manufacture of, J. Atkins 985,099
Shuttle threading implement, portable pneumatic, A. Ricci 984,606
Skirt marker, A. Seeling 985,070
Sled and wagon, combination, C. Heidenheimer 984,914
Smoke consuming furnace, Sudlow & White 984,979
Smut machine, J. A. Stensrud 984,613
Soap container, liquid, W. Williams 984,630
Solar heat motor, E. H. McHenry 984,585
Soot blower, T. E. White 984,871
Sound reproducing instruments, needle for, E. A. Allwood 984,789
Sound transmitters, mouthpiece for, J. Graham 984,558
Spool finishing machine, C. Livermore 984,680
Spring wheel, T. C. Erb 984,984
Spring wheel, W. I. Kimball 985,039
Square, die maker's, F. White 984,985
Stacker, pneumatic, J. E. Foster 984,540
Stocker, portable adjustable hay, Heedwell & McNew 984,670
Stamp, duplicating, Bosworth & Staley 984,533
Stamp mill, E. P. Dargin 985,012
Stamping, marking, or numbering machine, F. W. Merrick 984,588
Stand. See Umbrella stand.
Staple, J. R. Wheeler 984,629
Starching machine, E. E. Stone 984,864
Starting device, J. P. Looney 984,948
Stay bolt for boilers, flexible, B. E. D. Stafford 984,863
Steam boiler and stay bolt for same, B. E. D. Stafford 984,862
Steel tie, C. W. Walker 985,081
Stokers, feeding device for underfeed, C. W. Kinnear 984,568
Stokers, feeding fuel in blast feed, W. T. Hanna 984,662
Stopper extractor, W. Hak 984,661
Stove, W. F. Pinkerton 985,058
Stove, gas, W. J. Kennedy 985,038
Stoves and radiators, apparatus for gas heating, A. L. Boehm 984,743
Stovepipe hanger, M. P. Rendleman 985,062
Strainer, kettle, J. F. McCann 984,954
Stretching and drying frame, A. Bender ... 984,881
Stuffing boxes, device for cleaning the threads of, J. Magleon 984,577
Stump eradicator, M. S. Presler 984,965
Sugar, manufacture of, H. A. J. Mansoury 984,578
Surgical stomizer, Truesdale & Virgin 984,619
Surgical forceps, P. Frisch 984,756
Switch and fuse support and cover, W. J. Gibbons 984,759
Tally card system, J. B. Brophy 985,108
Tapping device, E. M. Hill et al 984,763
Telephone current selector, E. Garretson ... 985,024
Telephone exchange system, J. G. Mitchell 984,958
Telephone mouthpiece, antiseptic, W. M. English et al 985,021
Telephone receivers, automatic adjustable holder for, O. Lancaster 984,679
Telephone system, O. M. Cleveland 984,945
Telephone system, central energy, F. W. Dunbar 984,547
Telephone system, intercommunicating, R. H. Manson 984,686
Telephone systems, anti-induction apparatus for, Barrett & Condon 984,738
Terret, harness, B. Hanlon 984,909
Tether, decoy, J. H. Wattonburger 984,984
Thermostatic motor, F. Sherry 984,579
Thread cutting die, G. G. Brown 984,745
Ticket holder, F. L. O'Bryan 984,841
Tie spacer, Ali & Buckland 984,988
Tile backing, F. Alcan 984,637
Tire, T. W. Peet 984,597
Tire, pneumatic, A. Hormel 984,672
Tire tightener, Slay & Henry 985,073
Tire, convertible, E. T. Remisch 984,778
Torpedo clipping machine, F. Dutcher 984,892
Toy, L. C. Bailey 984,735
Toy, C. C. Turner 984,678
Toy flying machine, W. B. Line 984,683
Transmission mechanism, M. L. Jenkins ... 984,565
Trap. See Fly trap.
Trolley pole, automatic, J. W. Lang 984,767
Trolley restorer, W. H. Stebbins, Jr 984,712
Truck, car, J. E. Osmer 984,595
Truck, radiator, D. P. Larkins 984,941
Tubing, flexible metallic, C. T. Schoen 984,856
Turbine, steam, G. C. Wallace 984,788
Turn table, automatic automobile, P. A. Rasmus 984,967
Type casting and composing machine and typewriter, Link & Mergan 984,947
Type rings and other articles, forming, W. Hess, Jr 985,032
Typewriter shift frames, auxiliary support for, G. J. Griffiths 984,906
Typewriting machine, L. Wagner 984,621
Typewriting machine, J. Felbel 984,654
Typewriting machine, E. B. Hess 984,671
Typewriting machine, A. T. Brown 984,532
Typewriting machine, E. Kuhn 984,676
Typewriting machines, bell ringing mechanism for, Griffiths & Roderick 984,907
Typewriting machines, tabulating mechanism for, T. L. Knapp 984,934
Umbrella stand, F. P. McMenamin 984,955
Vacuum cleaner, F. C. Wheeler 984,628
Vacuum cleaning systems, separator tank for, C. R. Green 984,810
Vacuum tube, Winter & Peabody 984,726
Valve, W. G. Taylor 984,718
Valve, drain, C. L. Armstrong 984,994
Valve for vapor burners, T. Nagel 984,701
Valve, gas, M. Popkin 984,701
Valve, lock, M. J. Austin 985,100
Valve mechanism, J. W. Ledoux 984,820
Vapor burner, J. M. L. Fleming 984,657
Vehicle curtain support, C. Blackmore ... 985,105
Vehicle platform gear, J. Errett 984,895
Vehicle steering gear, F. E. Morey 984,960
Vehicles, lantern holder for, H. J. Holmes. 984,565
Velocipede, D. G. Cauwels 984,648
Volatile products from wood, extracting, F. A. Kummer 984,818
Voltage regulator, automatic, G. A. Burnham 985,109
Washing machine gearing, C. J. Marth 984,831
Water heater, S. W. Brown 985,001
Water jacket, S. W. Traylor 984,805
Water purifying apparatus, Woods & Greth 984,575
Water tube boiler, J. R. Bell 984,886
Water wheel, J. S. Beaver 985,104
Welding, electric, E. Thomson 984,719
Welding machine, electric, Pryor & Trapp. 984,968
Weft butting machine, E. Winkley 984,631
Wheel. See Automobile wheel.
Wheel cutting machine, M. Pedersen 984,777
Wheel detacher, V. W. Straub 984,978
Whip socket, R. A. Bell 985,022
Whip socket, locking, C. W. Winner 985,090
Wind power, apparatus for storing and distributing, S. Pichault 984,599
Wind shield, folding, E. H. Crawford 984,848
Windmill governor, W. A. Fifield 984,735
Window construction, J. J. Smith 984,611
Window construction, Worst & Kilmer 984,990
Wire splicer, M. W. Fry 985,023
Work support, W. C. Meyer 984,772
Wrench, Mendenhall & Wonsmos 984,691
Wrench, E. Green 985,028
Wringer, S. C. Lawlor 984,819
Yarn, elongating or drafting machine for production of recondensed, Hoyle & Barker 984,922

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